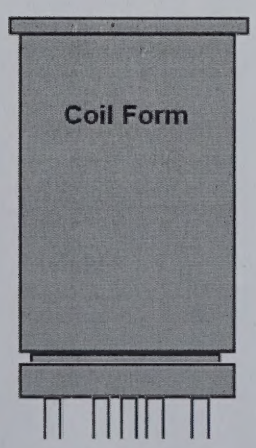
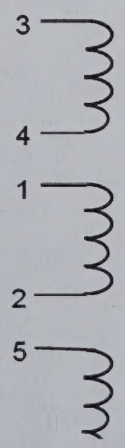
No. 60A	Sec	20 Enamel	1	4 1/2	5
10 Meters	Pri	24 Enamel		2 5/6	5
	Tick Det	32 Dbl Silk		1 3/4	5
	Tick RF	32 Dbl Silk		2 1/6	5
No 61A	Sec	24 Enamel	5 5/6	20 5/6	14
20 Meters	Pri	34 Dbl Slik		15 5/6	14
	Tick Det	32 Dbl Silk		3	14
	Tick RF	32 Dbl Silk		4	14
No 62A	Sec	30 Enamel	1 5/6	10 5/6	Space coil 1 inch long
30 Meters	Pri	30 Enamel		8 5/6 Note 2	Pri Interwound in Sec
	Tick Det	30 Enamel			
	Tick RF	30 Enamel			
N0. 63A	Sec	24 Enamel	5 5/6	20 5/6	14
40 Meters	Pri	34 Dbk Silk		15 5/6	14
	Tick Det	32 Dbl Silk		3	14
	Tick RF	32 Dbl Silk		4	14
N0 64A	Sec	24 Enamel	16 5/6	34 5/6	24
80 Meters	Pri	34 Dbk Silk		21 5/6	24
	Tick Det	32 Dbl Silk		3	24
	Tick RF	32 Dbl Silk		4	24
No. 65A	Sec	28 Enamel	38 5/6	62 5/6	40
160 Meters	Pri Det	32 Dbl Silk		25 5/6	40
	Tick Det	32 Dbl Silk		4	40
	Tick RF	32 Dbl Silk		5	40

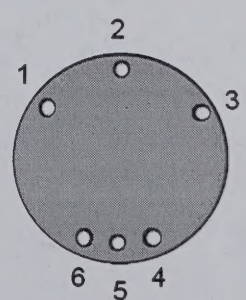
Notes

Note 1. Tickler Should be 1/8" from start of Primary
Note 2. 33.1 pf across RF primary to bring trimmer into range

Dbl Silk = Double Silk
Dbl Ctn = Double Cotton







BOTTOM VIEW

National SW-3 Series 60 Coils

Coil	Winding	Wire Size	Tap	Total Number of Turns	Turns Per Inch
No. 60	Sec	16 Enamel		2 5/6	5
9-15 Meters	Pri	24 Enamel		2 5/6	5
19-35 MHz	Tick	32 Dbl Silk	Note 1	1 5/6	5
No. 61	Sec	16 Enamel		6 1/4	5
13.5-25 Meters	Pri	24 Enamel		5 5/6	5
12-21 MHz	Tick	32 Dbl Silk		2 1/6	5
No. 62	Sec	18 Enamel		11 5/6	8
23-41 Meters	Pri	24 Enamel		9 5/6	8
7-12 MHz	Tick	32 Dbl Silk		2 1/6	8
No. 63	Sec	18 Enamel		19/5/6	14
40-70 Meters	Pri	34 Dbl Silk		12 5/6	14
4.2-8 MHz	Tick	32 Dbl Silk		2	14
No.64	Sec	24 Enamel		34 5/6	24
65-115 Meters	Pri	34 Dbl Ctn		21 5/6	24
2.5-4.5 MHz	Tick	32 Dbl Silk		3 1/6	24
No. 65	Sec	28 Enamel		62 5/6	40
115-200 Meters	Pri	32 Dbl Silk		38 5/6	40
1.5-2.7 MHz	Tick	32 Dbl Silk		4	40
No. 66	Sec Det	32 Dbl Silk		98 5/6	Close Wound
200-360 Meters	Sec RF	32 Dbl Silk		102 5/6	Close Wound
690-1500 KHz	Pri Det	32 Dbl Silk	10 5/6	47 5/6	Close Wound
	Pri RF	32 Dbl Silk		47 5/6	Close Wound
	Tick	32 Dbl Silk		6	Close Wound
N0.67	Sec Det	32 Enamel		166 5/6	Close Wound
360-550 Meters	Sec RF	32 Enamel		171 5/6	Close Wound
500-900 KHz	Pri Det	32 Enamel		82 5/6	Close Wound
	Pri RF	32 Enamel		82 5/6	Close Wound
	Tick	32 Dbl Silk		8	Close Wound
No. 68	Sec	36 Enamel		270 5/6	Close Wound
500-800 Meters	Pri	32 Dbl Silk		36 5/6	Close Wound
320-650 KHz	Tick	34 Dbl Silk		18	Close Wound

Ham Bands Full Bandspread

INSTRUCTIONS
for
AMATEUR BAND SPREAD COILS

These coils are designed for use in the standard National Thrill Boxes, and may be simply plugged in the coil sockets without the necessity of making any circuit changes or altering the tuning condensers. The grid leads attached to the coils must be used instead of those employed with the standard coils. The 11-A, 13-A, 14-A, and 15-A coils are for use in the ACSW5, DCSW5, ACSW45, ACSW3, (employing 235 tubes), the universal SW3 (DC) and the SW34. The 61-A, 63-A, 64-A, and 65-A coils are for use in the SW58, and the later model ACSW3 employing type 58 tubes.

The detector coil is supplied with the grid condenser and grid leak mounted inside, and has a trimmer condenser at the top for properly locating the band on the dial. This arrangement is not necessary on the R.F. coil, as the trimmer condenser on the set furnishes the capacity necessary for correct ganging. The detector is located at the left hand side in the AC or DC SW5, and the ACSW45 models, and at the right hand side in the SW58, SW34, and all models of the SW3.

The detector coil trimmer is adjusted at the factory, but it should be checked, since packing, shipping, etc., may have caused some change. The adjusting screw is at ground potential, so a metal screw driver may be used. When properly adjusted, the high frequency edges of the various bands will be between 65 and 70 on the dials of the SW5, SW45, and SW3 models, or between 30 and 35 on the dials of the SW58 and SW34. The spread may be increased by slightly tightening the trimmer, so that the high frequency limits occur at a lower dial reading. Conversely, the spread may be reduced by loosening the trimmer.

When the trimmer is finally adjusted, a reasonable amount of care must be exercised in handling the coil or its calibration will change.

THE COMMUNICATIONS RECEIVER

EDITED BY **WILLIAM FIZETTE, W2DGB**, RR 1, BOX 55, HENRYVILLE, PA 18332
PLEASE INCLUDE SASE FOR REPLY.

The Remarkable National SW-3

The descriptive term "remarkable" is often used carelessly. But when it is applied to a little stripped-down regenerative receiver, born in the cash-scarce years of the early 1930s, which had a 14-year production run of over ten thousand units, which was used worldwide in all sorts of applications and environments, and which is now a sought-after collector's item, the word is well chosen.

A number of communication receivers from the "golden age" have accumulated a substantial body of literature. The SW-3 is certainly one of them, and my file is replete with numerous articles from *CQ, QST, Electric Radio, The OTB*, and other publications. Noteworthy among these is the landmark *QST* article by Jim Millen, (then W1AXL and later W1HRX) (1) the two papers in *CQ* by Bill Orr, W6SAI (2), (3), and a superb article in *Electric Radio* by my fellow National enthusiast Jim Hanlon, W8KGI (4).

There are other delightful and informative articles by Faulstick (5), in *Riders Manuals* (6), in various National Company instruction manuals, and by Ruggere and Troe (7). Additional information on the coils, as well as a summary of the various power supplies, can be found in *The OTB* (8), (9). There are, of course, many other sources, but the above will give the reader a good overview.

Physically, the SW-3 in its various models is an ugly little black steel box with a hinged lid and a longest dimension of less than 10". It has four front panel controls. There are three tubes, with two plug-in coils for each frequency range. The power source is external: batteries or certain of the famed National "doghouse" AC supplies.

Background

The National Company began as a manufacturer of radio parts, and in time produced finished products using those parts. Thus, the SW-3 with its plethora of interesting features did not just suddenly emerge from the National laboratory. There was a considerable prior development history that included the distinctive tuning capacitors, the unique dial and knobs, the 5880 "doghouse" power supply (with a circuit that eliminated "tunable hum"), and especially the distinctively-based National R-39 low-loss plug-in coils. (NOTE: The question is frequently posed as to why National didn't use the standard six-pin tube base; the answer is simply that their version was designed first.)

One prior product was the 1930 SW-5 five-tube "Thrill Box." It was a deluxe short-wave radio housed in an ornate metal cabinet and using grooved R-39 plug-in coil forms. The SW-5 sold for $85.00, and the 5880 AB power supply cost an additional $20.00.

Driven by the adverse economic conditions of the deepening Depression, James Millen's National design group stripped the SW-5 circuit of everything not essential for communications use while keeping the fundamentals in place. They removed the power audio amplifier (the user would now need headphones), replaced the tuning capacitor's fancy drum drive with the much cheaper Type C dial, and changed the capacitors to an in-line configuration. The cabinet was now a simple, uncomplicated steel box with a hinged lid.

In short, the Millen group produced a very basic radio for a relatively low price, which the user could supplement with additional coils, an audio amplifier, and so forth as money permitted. Wholesale Radio Service Co. in New York listed the set at $32.34. The price included three sets of amateur-band coils, but not the tubes. This was considerably less than the cost of the SW-5, and much more in line with prevailing economics. The price of the matching #5880 power supply was $20.30, essentially unchanged.

The full-page introductory ad for the SW-3, reproduced here, appeared in the October 1931 issue of *QST*. This, of course, followed directly on the September *QST* article mentioned above, and is an excellent example of the sophistication of National marketing strategy under Millen's guidance. Another example, of course, is the offering of accessory coil sets covering a wide range of frequencies. Who could resist spending a few dollars now and then for coils that opened up new listening possibilities?

The Circuit of the SW-3

The three-tube SW-3 circuit includes an r.f. stage, a regenerative detector, and a single audio amplifier. There were eventually three versions, referred to now as Models I, II, and III. Model I is scarce today. Model II debuted about 1936. It is the one mostly found today, and is the subject of my restoration column elsewhere in this issue. See that column for a copy of the schematic.

The Model III, designated SW-3U, "The Universal," was manufactured in limited quantities in the late 1930s and up through 1945. It was designed to use either 6-volt metal tubes or 1.4-volt battery tubes. There are not many Model IIIs around today.

While the tubes and some of the components and circuitry varied somewhat as different versions of the SW-3 emerged, the basic circuit remained constant, as did the external appearance. One minor exception to the external appearance differentiates the first model from the succeeding versions; the lid of Model I is flat, while the later models has a raised finger lip in the front center. Also, looking down inside the Model I with the lid raised, the two-section tuning capacitor consists of two National type SE-100s ganged with an insulated coupler, and held to the chassis with four screws. Subsequent versions used a dual National 2SE-100 mounted with a special bracket in the rear, and directly to the main dial drive, a National Type C, in front.

The S-101 Audio Coupler, a potted transformer device mounted at the rear of the tuning capacitor, appears to have been introduced with the SW-3. I haven't found it listed in the earlier National catalogs at my disposal. The unit consists of a 700 Hy audio choke, a 0.01 mfd coupling capacitor, and a 250,000 ohm grid resistor. It is easy to check with simple radio bench test gear, and can be rebuilt if necessary. Details are in the restoration column in this issue.

Special Features

William Orr began his *CQ* magazine series on classic radios with an article on the SW-3 (2). Orr was a friend of Jim Millen (formerly the VP in charge of product development for the National Company). He stated that the 1930 SW-3 design, which was years ahead of its time, was marketed to commercial airlines (for which its light weight was ideal) as well as radio amateurs. Pan American Airways, believing that good c.w. equipment was more efficient than the existing radiophone apparatus, used the SW-3s on its overseas clippers—mainly the South American routes.

One of the major features of both the SW-3 and the predecessor SW-5 was dependable sin-

Setting a New Standard
in HF Receiver Design
NATIONAL SW-3
This new Ham receiver follows essentially the same circuit as the new NATIONAL SW-5 THRILL-BOX but being for headset use only, omits the Push-Pull Audio.
FULL A. C. MODEL
Uses Type No. 235 and 227 tubes, and operates on full A.C. with National type 5880 Power-Pack, specially designed for humless operation with RF filter, two-section Hum filter and electrostatic shield between secondaries and line winding (eliminating "tunable" hum).
UNIVERSAL MODEL
Uses new 6 volt, five-prong heater type No. 235 and 237 tubes for battery operation; or Type No. 235 and 227 tubes can be used with 2.5 volts A.C. on the heaters and batteries for B-supply.
SPECIAL SHIELDING
Special shielding in the SW-3, the result of careful research, is one of the reasons for its remarkable efficiency.
HIGH SIGNAL-TO-NOISE RATIO
The combined results of careful circuit design give exceedingly high signal-to-noise ratio.
COMPACT — ADAPTABLE TO PORTABLE, AIRCRAFT AND BOAT USE
Receiver is extremely compact: 9" x 9¾" x 7". Simple, attractive metal cabinet is standard equipment, and forms integral part of the shielding. It can be equipped with hooks for spring mounting on airplanes and will fit in a very small space.
SINGLE CONTROL
The SW-3 has true single control. See and forget the antenna trimmer. Special HF Variables have insulated main bearings and constant-impedance pig tails and are insulated with R-39.
BAND-SPREAD COILS STANDARD EQUIPMENT
Standard equipment are Band-Spread Coils for 20, 40, and 80-Meter Amateur Bands.
THE PRICE IS RIGHT
The price of the SW-3 puts it within the reach of every amateur. Write us for full particulars and prices using coupon below.
CALIBRATED ATTENUATION CONTROL
In the SW-3, the attenuation-control is an Audibility Meter. Designed so that angle of rotation is directly proportional to the R-Rating of signal intensity, the signal intensity may be read directly on the control. The control wheel is so mounted as to be operated with the same hand as used for tuning, leaving the other free for sensitivity control.
REAL GAIN IN RF STAGE
The design makes possible a real RF gain because of lower plate impedance of 235 tube.
SMOOTH SENSITIVITY CONTROL
Employing a hitherto unknown and unused characteristic of the 235 Variable-mu tube, the point of maximum sensitivity is approached on an inverse exponential curve. Result: — extremely stable operation at maximum sensitivity, without critical control-setting.
NATIONAL
SW-3
AMATEUR HF RECEIVER
COUPON
National Co. Inc.
61 Sherman Street
Malden, Mass.
Gentlemen:
Please send me full particulars and prices on your new SW-3 Ham Receiver.
Name.....
Address.....
QST-10-31
Say You Saw It in QST — It Identifies You and Helps QST

Original announcement of the SW-3 receiver from the October, 1931 QST.

gle-dial control, with the rf and detector gang-tuned. The success of this system in National receivers was due to careful engineering and manufacturing, using quality parts.

The Tuned Circuits. The tuning capacitors, specially built by National, have two electrically-independent ganged sections. The rotors were isolated from the frame and each other. The coils were of moisture resistant R-39 molded formulation and wound with distinctive wire. They were grooved for the primary and secondary turns and had slot windings for the ticklers.

The bandspread coils had tapped secondaries, with a trimmer capacitor and grid leak located inside the detector coil. When these coils are used, the grid clips are removed from the caps of the r.f. and detector tubes and placed on fiber blanks provided in the cabinet. Grid leads from the coils are clipped on instead. These were very stable coils that functioned well under adverse humidity conditions, and the combination of quality components gave the tank circuits an inherent stability that was remarkable for the day.

Ten coil sets covered the useful range of 9 to 2000 meters, with bandspread coils available for the five major amateur bands then in use. Model I used the 10-20 series; II the 60-70 series; and III used the 30-40 series coils. The only apparent difference is the number of tickler turns in the slot winding.

The bandspread coils have the suffix "A" after the number. Early coils were not numbered, but color coded, with either a dot on the bottom, or a color-filled slot on the top edge. Coils from one series may be usable in another, but obtaining proper regeneration (it should occur about mid-range on the control) could be a problem.

Some signals can still be picked up even without proper regeneration, allowing you to check the frequency range of unmarked coils. If you have access to the coil specifications, you can rewind the tickler of a mismatched coil. Often a single turn, or a fraction of a turn, will make the difference.

As of this writing, coil specifications, as well as forms for winding new SW-3 coils can be obtained from James Fred (5355 S 275 West, Cutler, IN 46920, phone 765-268-2214). These excellent quality forms do not have the primary and secondary winding grooves of the original National parts, though they do have the tickler slot. Wind your coils carefully and they will work fine. You may also find some defunct original National forms that can be rewound. If you take this job on, a good source of quality wire is an electric motor repair shop.

Other Issues. Proper interstage shielding is critical for a sensitive, controllable regenerative receiver. Any interaction between the RF and detector stages must be minimized. Not only does the SW-3 have a standard shield for the r.f. tube, but the RF and detector stages are isolated by distinctive metal shields welded to the cabinet. Details of the development of this and other features are in Millen's landmark *QST* article, which was often included in SW-3 instruction manuals.

The thumbwheel gain control is calibrated in R units (the signal-strength units of the day). I've seen various National SW-3 schematics placing this control across the antenna coil, in the cathode of the RF stage, in the RF grid return, or in the grid of the audio stage. The Model II described in my restoration column in this issue has the control in the audio stage, with the RF tube operating wide open. That approach appears less than satisfactory, and when time permits, some tinkering is indicated. This may in part explain a comment by Paul Bohlander, W3VVS, who has restored twelve SW-3s and found that while they all look alike, "they are all different."

Nowdays there is a romantic aura surrounding the SW-3, which after all was just one product among many offered by just one company in the growing electronics industry of the 1930s. Its popularity has to be traced to a combination of adroit marketing and careful engineering, coupled with over a decade of experience and National's reputation for quality products in this new field. For years the SW-3 was used by hams, government agencies, commercial stations, airlines, ships, expeditions, and anywhere else that a versatile, simple, light-weight dependable receiver could apply.

The radio worked, and it worked well. Its success certainly must have done a lot for National's reputation and cash register.

Additional Comments

I asked Jim Hanlon, who has contributed to this column in the past and written extensively for *Electric Radio* magazine, to review this article. His own article on the SW-3 has been previously cited (4). His paraphrased comments follow.

1. Your date of 1936 for the introduction of the Model II agrees with Orr's article. However, the fellow who sold me my Model II told me it was built in 1933 or 1934. He should have known, since he was a member of the radio club that originally purchased it and later bought it from the club.

2. Regarding a source of coil wire, I would

(continued on page 32)

COMMUNICATIONS RECEIVER, *continued from page 30*

add that Antique Electronic Supply www.tubesandmore.com lists magnet wire in at least 8 gauges. They sell full spools for reasonable prices, $5.50 for a 100-foot spool of #21 or #22, up to $4.95 for a 750-foot spool of #42. They also sell Celanese-covered wire, including Litz wire, by the foot.

3. You might want to tip off your readers about the information regarding winding a 30-meter bandspread coil pair that appeared in my 1993 article. I don't know of any other place that it has appeared.

4. Finally, I would also suggest that you assure your readers that the SW-3 is more than just an interesting antique. Several of them show up in the various AWA contests, usually paired with a 210 Hartley, TNT or TPTG. I've worked the east coast from New Mexico on 80 meters with my pair. The SW-3, while not at all selective, is sufficiently sensitive to hear atmospheric noise with its tuned RF amplifier stage. With a little coaxing and given a not too crowded band, it will do just as good a job as a modern superhet.

REFERENCES

(1) Millen, James, *QST*, September 1931.
(2) Orr, William, *CQ*, July 1971.
(3) Orr, William, *CQ*, February 1978.
(4) Hanlon, James, *Electric Radio*, August 1993.
(5) Faulstick, Roger, *Electric Radio*, Dec. 1993, January and February 1994.
(6) Riders Manual, Volume 14. (NOTE: There is gold mine of information on other National receivers in this reference.)
(7) Ruggere, R., and Troe, James, *ARCA Gazette*, Vol. 19, #4.
(8) Fizette, Wm, *The OTB*, August 1993.
(9) Fizette, Wm, *The OTB*, February 1993.

PEAK EFFICIENCY DESIGN ON THE SHORT WAVES

Engineering a Universal
AC & DC Receiver
Especially Designed for
Amateur Band Reception

by
James Millen, M.E.

Price 10 Cents

1111

WE ARE indebted to QST Magazine for permission to republish much of the material contained in this Second Edition, describing the 1933 SW-3 receiver.

This is one of a series of pamphlets concerned with outstanding developments in the field of transmitting, high-frequency and broadcast receivers, frequency measuring apparatus and other equipment of interest to the radio and communications engineer.

James Millen

THE NATIONAL COMPANY

Malden, Mass. U. S. A.

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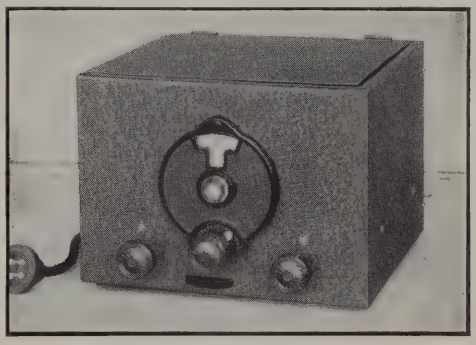
Peak Efficiency Design on the Short Waves

Engineering a Universal AC & DC Receiver Especially Designed for Amateur Band Reception

By James Millen, M.E.

THE truly modern short wave receiver represents an advance in engineering design over the moving tickler regenerator of a decade ago comparable with the superiority of the 1933 broadcast receiver with its quiet a-c, perfected radio and audio systems, over its progenitor of that technically distant era. The short wave engineer has partaken of long wave progress in the improvement of audio frequency and power circuits and in the development of tubes, notably the types 58, 36 and 37, which contribute to quiet and stable operation and, in carefully engineered circuits, permit real radio frequency gain even in the region of megacycles! Simultaneously, the short wave engineer had his own peculiar problems to solve, involving the successful ganging of very high frequency circuits, the development of satisfactory shielding, the reduction of stray coupling effects through the progressive design of more and more efficient choke coils and the segregation of circuits, the perfection of volume and regeneration control systems, and the conservation of high frequency energy through the invention of practically no-loss insulating materials.

It is the purpose of this article to describe a receiver — the 1933 model of the famous SW-3 series — in which the successful solutions to all these considerations have been embodied. In addition to its peak efficiency performance on all short wave lengths, its peculiar adaptability to either a-c, battery or intermediate operation (combining battery and line-power in conformation with individual requirements) recommends the SW-3 to the discriminating amateur.



SINGLE-CONTROL TUNING OF TWO TUNED CIRCUITS

Band spreading, calibrated volume control, complete shielding and adaptability to either a.c. or battery operation are the salient features of this receiver. The "set and forget" antenna trimmer control is at the left and the regeneration control at the right, with the operating edge of the calibrated volume control disc immediately below the main tuning dial.

Battery vs. A-C Operation

Although a little over two years ago a-c operation of an amateur-band receiver was considered rather impractical by the amateur fraternity, the readily recognized superiority of alternating current tubes over the battery type resulted in such an accelerated development of the a-c receiver that it was not long before the problems of a-c operation were well mastered and the solutions applied to short wave design.

In recent months, increasing numbers of experienced operators have been switching to the use of combination a-c and battery operated receivers, and additional facts concerning their operation have been determined. It is well known that unless an unusually high quality power-pack is employed for the completely a-c operated high-frequency receiver, it is generally found that the combination of a-c filament heating and battery plate supply results in steadier reception when receiving weak cw signals with an oscillating detector. This may possibly be due to the isolation of the two sources of power supply, or, perhaps, to the elimination of fluctuations in the plate supply voltage caused by minor variations in the line voltage or poor power unit design. Regardless of the exact reason, it must be admitted that battery plate supply is an improvement under some receiving conditions, unless the really high grade pack especially designed for high frequency receiver operation is employed.

The life of the "B" batteries will be long, with the usual few milliamperes drain demanded by a three-tube set, and the first cost of the filament transformer and 135-volt block of batteries will be considerably lower than that of an efficient power supply designed for satisfactory high-frequency receiver work. There is also another advantage to the use of "B" battery plate supply — namely the elimination of the regeneration-control "detuning effect" almost invariably encountered in com-

pletely a-c operated ham receivers using improperly designed power packs. It is probably the superior regulation characteristic of "B" batteries or high quality pack that overcomes the trouble. In any event, the combination a-c filament supply "B" battery plate supply type of operation seems to be as free from such trouble as when the receiver is entirely battery operated.

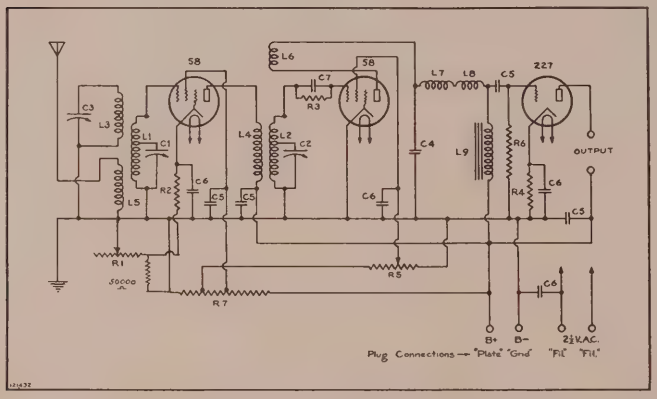


FIGURE 1 — CIRCUIT DIAGRAM OF THE ACSW-3

This receiver employs only a-c tubes, as indicated, and should be selected for complete a-c operation, or for partial a-c operation (using plate batteries) where a 2.5 a-c heater potential will always be available. The circuit constants are as follows —

L_1, L_2, L_3, L_4, L_5 and L_6 — R.F. Transformers.
L_7 — No. 100 Ultra High Frequency R.F. Choke.
L_8 — No. 92 Low Radio Frequency Choke.
L_9 — 700 Henry Choke — Part of S-101 Audio Coupler.
C_1 and C_2 — Ganged S.F.L. 270° Tuning Condensers with isolated rotors. 90-μμf per section.
C_3 — Midget Type Trimmer Condenser — 50-μμf.
C_4 — 250-μμf mica by-pass condenser.
C_5 — .01-μf non-inductive mica fixed condensers.
C_6 — .5-μf non-inductive paper by-pass condenser.
C_7 — 100-μμf small mica grid condenser. Incorporated in Detector R.F. transformer.
R_1 — 3000 ohm potentiometer — special taper — used as gain control.
R_2 — 300 ohm cathode resistor, 2 watt type.
R_3 — 5 megohm detector grid leak.
R_4 — 2000 ohm cathode resistor, 2 watt type.
R_5 — 50,000 ohm potentiometer for regeneration control.
R_6 — 250,000 ohm audio grid resistor — part of S-101 Coupler.
R_7 — Voltage Divider-total resistance 12,000 ohms.

For complete battery operation the 6-volt d-c heater type tubes are far superior to any others previously available for such work. Gone are all the noises, microphonics, and other such troubles formerly associated with the use of battery tubes. Also, the heater being designed for 6-volt operation, restores to use the storage battery or "A" eliminator generally to be found in every amateur station. In the case of the 3-tube receiver described herewith, the total current consumption at six volts is under one ampere. Employing the new heater-type battery tubes, it is possible to design a battery receiver of similar characteristics to the a-c models. Thus the amateur in the rural districts, as well as those on exploration parties, expeditions, etc., may have essentially the same type of set as their brother operators located in the a-c districts.

General Design

In a receiver designed with the peculiar requirements of amateur operation in mind, there is little necessity for audio amplification of loudspeaker magnitude. The concentration desirable for communication reception, particularly of weak signals through interference and QRN, is achieved with less effort when ear 'phones are used — a general practice in amateur and commercial stations. The power amplifying stage has therefore been omitted in the design of the SW-3.

This omission is still further justified in consideration of the actual gain secured in the radio frequency circuit, even at 30 mc, in consequence of the new tubes and highly efficient r-f design to which reference has already been made. The high amplification factor, high transconductance and the plate impedance characterizing the new tubes have enabled the engineer to achieve a degree of sensitivity and selectivity that have heretofore been little more than experimental ideals. The use of these tubes has necessitated the redesign of the plug-in inductors in the antenna-radio-frequency and detector circuits.

The tubes employed as indicated in the wiring diagrams (Figures 1 and 2) function, from left to right, as radio-frequency amplifier, beat-frequency-oscillator-detector and one stage audio amplifier. This arrangement is comparable in many ways to the more elaborate short wave superheterodyne receivers, and has the advantage of a definitely better signal to noise ratio.

Aside from the gain achieved in the audio frequency circuit, this tube also serves as a very essential coupling medium between the output of the detector and the headphones (or additional amplification if employed). In this function, it promotes smooth regeneration, freedom from fringe howl and back-lash, and, with other elements in the circuit, eliminates the feedback from the 'phone cord to the input circuit of the receiver.

Shielding

The required stability of a communications short wave circuit presents special problems in view of the peculiar characteristics of very high

frequencies and the maintainance of a stable oscillating condition during beat-note reception. A large part of the burden of stability is placed on the shielding — which must perform a double function in providing adequate circuit isolation with the minimum reduction of high radio-frequency efficiency.

While it would seem that the single stage of r.f. and regenerative detector type of circuit is about as simple an arrangement to build as can be imagined, such has been found far from true where more than mediocre performance is demanded. For instance, if inadequately shielded, the r-f tube will oscillate whenever the detector regeneration control is advanced. This condition exists to a surprising extent in both homemade and commercial receivers in use today. Such receivers are tolerated, it would seem, simply because the owners have never operated a receiver employing the same circuit properly shielded. There just isn't any comparison.

The mere fact that the r-f stage is apparently stable when the detector is approaching an oscillating condition, is not necessarily an indication of perfect shielding, as interlocking still may be present to an obnoxious degree.

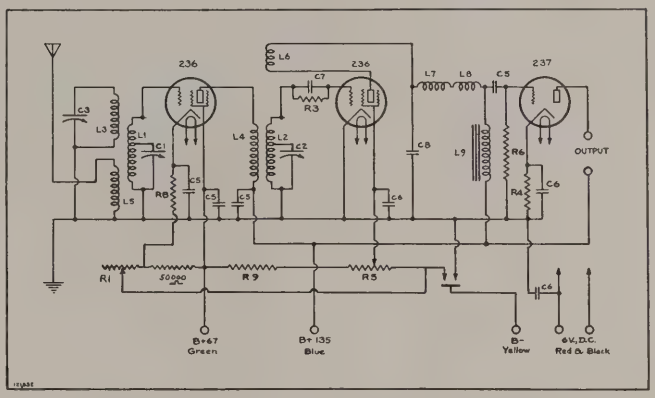


FIGURE 2 — CIRCUIT DIAGRAM OF THE DCSW-3

This is the combination circuit which should always be selected when battery operation may be required. It can, however, readily be converted to a-c operation using the standard 235 and 227 tubes. The circuit constants are identical with those indicated in Figure 1, with the following exceptions —
R_8 — 350 ohm resistor.
R_9 — 20,000 ohm 2-watt type resistor.
SW — Regeneration control and cathode circuit switch.

Consideration of the receiver being described will demonstrate that there is far more to shielding than the mere boxing off of the different parts of the circuit. Offhand, the arrangement shown in Figure 3A would appear satisfactory. However, this seemingly ideal arrangement, with the coils, tubes and condensers of the two circuits completely shielded from each other, is far from perfect. It was found that with a watertight joint between the shield and the base there was no oscillation trouble with the r-f amplifier, although there was an annoying amount of interlocking. As soon as the chassis was placed in a metal cabinet, however, and the cover closed, the r-f stage oscillated violently!

Next tried was the arrangement shown at B in Figure 3, with even less satisfactory results. Furthermore, the lack of symmetry of the shielding made it very difficult to gang the r-f and detector tuning condensers.

The next experiment comprised the shielding system shown at C in Figure 3. This arrangement worked fairly well in comparison with its predecessors, but here, too, there was still excessive interaction. The compartments were probably too large, for the isolating effect of the coil compartments decreases very rapidly as the compartment size increases. Another disadvantage of this arrangement was the requirement of tube shields. There was, however, no perceptible change in the shielding effect when the chassis was placed in a metal cabinet.

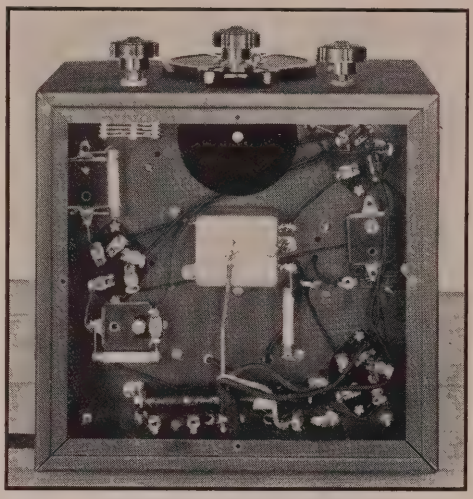
With the experience gained with models A, B and C, we arrive at the arrangement illustrated at D. Here the compartments are small enough to shield properly, and yet large enough not to increase the coil losses appreciably. Furthermore, there is no common partition between the coil compartments as exists in designs A and B, which, in all probability, was responsible for the "cover" effect. The r-f tube shield was found essential in order to shield the plate lead from the coil and prevent oscillation.

In the model finally adopted in the SW-3, it was found advantageous to make the vertical parts of the shielding integral with the metal cabinet rather than to weld them directly to the chassis. It is also desirable to insulate the vertical parts of the shielding compartments from the chassis itself with a $\frac{1}{8}$" air gap and to weld them to the sides of the metal cabinet. The chassis, in turn, is grounded to the cabinet by mounting screws on each side. Such an arrangement completed the shielding job by reducing interlocking to a negligible degree.

A further indication of the trouble to be experienced in attempting to use a common partition between the coils in a shortwave receiver is illustrated at E and F in Figure 3. This problem was recently encountered in the design of another receiver employing the same circuit. The separate compartments completely eliminated the r-f oscillation and interlocking difficulties.

Steel vs. Aluminum

A word regarding the relative merits of steel and aluminum shielding is of interest at this point. It is well known that on the extremely low frequencies, say for instance 60 cycles, iron is definitely better as a magnetic shielding material than aluminum. As the frequency increases, however, this difference rapidly diminishes, until at broadcast frequencies it has practically completely disappeared. On still higher frequencies, from a purely shielding point of view, there appears little, if any, actual difference.



THE UNDERSIDE OF THE A.C. MODEL WITH ITS BASE-PLATE REMOVED

However, there are several other aspects to be considered in addition to the pure shielding effect, such as the introduction of losses when shielding is placed close to a coil. It is for this reason that in the design of the receiver care has been taken to keep the steel shielding partitions everywhere separated from the r.f. transformers by distances at least equal to the coil diameters. At this, or greater distances, there is no noticeable difference in the resistance of the r-f transformers whether the shielding be aluminum or steel. In the design of receivers where it is necessary to place the shield closer than the diameter of the coil at any point, then there is a marked advantage in using aluminum or some other non-ferrous material.

In high frequency work, our present concern, the real advantage of the use of steel over aluminum lies in its shielding of the receiver as a whole from the low frequency (60-cycle) magnetic field which often completely envelops the ham operating table and results in a strong a-c hum in connection with aluminum shielded battery type receivers. There is also the consideration of perfect shield joints, which are difficult to obtain with aluminum but readily achieved with steel by welding.

Elimination of Stray Coupling

While shielding is undoubtedly the most effective single medium employed in circuit isolation, the highest degree of short wave efficiency can only be obtained when shielding is supplemented by circuit refinements designed to reduce intercoupling effects to an imperceptible minimum.

The radio frequency filter in the detector plate circuit of the SW-3 is the result of careful study of the problems involved. Highly undesirable operating conditions result when excessive r.f. is permitted to invade the a-f channels. The predominant characteristic of such a condition is the presence of hand capacity effects on all parts of the audio frequency system, including the headphones, cords and even the metal receiver cabinet. Another symptom is the exasperating fringe howl as the detector approaches oscillation. A sticky regeneration control — an apparently excessive amount of lost motion — is directly traceable, in many instances, to inadequate filtering in the detector output circuit.

The use of a detector tube having a high plate impedance precludes the employment of a fairly large bypass condenser which would necessarily attenuate the higher audio frequencies when it occasionally happens, even in amateur operation, that high quality 'phone reception is de-

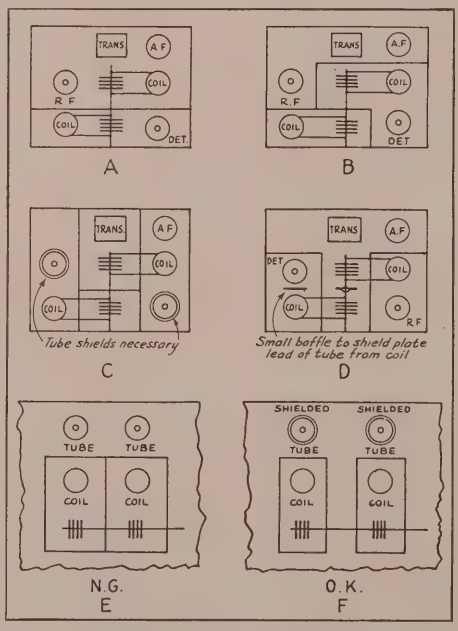
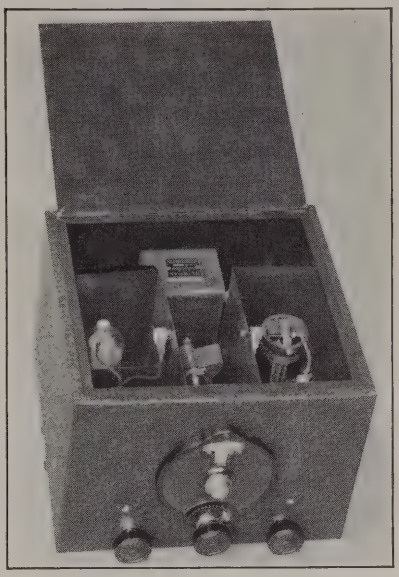


FIG. 3 — TYPES OF R-F SHIELDS SHOWING THE EVOLUTION OF THE HIGHLY EFFICIENT SYSTEM EMPLOYED IN THE SW-3

sirable. The matter resolves itself into the familiar high radio-frequency problem of efficient choke design. The inductance of the short wave choke in the SW-3 is only 2.5 millihenries, but what is more important the distributed capacity has been reduced to 1 mmf!

A low-radio-frequency choke is placed in series with the h-f reactor to permit effective regeneration control on wavelengths over 100 meters, thus permitting the efficient range of the receiver to be extended into the broadcast band, and above, by means of larger plug-in coils. On long wavelengths the choking action is the sum total of the individual inductances of the two chokes, affected by a negligible quantity of mutual inductance. On high frequencies, the reactance of the larger choke coil is negative — the windings are bypassed by its distributed capacity — and only the smaller choke coil functions

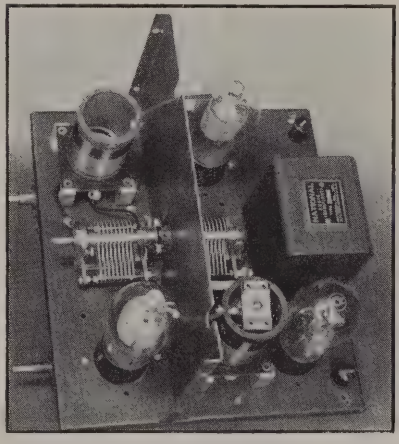


WITH THE COVER OPENED

The plan of the internal arrangement is the same as that shown at D in Fig. 1. With the band-spreading coils in place, the normal control-grid clips fasten to the dummy insulating plugs mounted on the compartment walls. The partitions are welded to the sides of the cabinet but are insulated from the base by an air gap.

At the present st.age of the radio art, there is no excuse for a tw o condenser type of receiver that is not single dial control in the fullest sense of the term — even on short wavelengths. Careful engineering in the SW-3 has resulted in highly efficient uni-control, but here, too, the problem of stray coupling elimination had to be solved. This is the coupling through those portions of the tuned circuits which happen to be common in parts of the gang condenser frame in the conventional multi-section tuning capacitor. While the paths involved are very short, an inch or two represents an appreciable part of the total conductor length at frequencies above 15 megacycles, and is sufficient to cause instability and circuit interlocking.

To overcome this trouble a special tuning condenser was developed in which both rotors are entirely insulated from the condenser frame and from each other. This design makes it possible to isolate completely the input and output circuits of the radio-frequency stage, resulting in a perfectly stable system, even at the highest frequencies to which the receiver will tune.



A GOOD EXAMPLE OF HOW NOT TO SHIELD

A study of shielding in the development of the receiver described brought out some surprising points. The example illustrated looks good but isn't, as explained in the text. This arrangement is the same one shown at A in Fig. 1.

Volume Control

It has heretofore been considered that the simple regeneration control in the detector circuit — assisted, perhaps, by an a-f attenuator for headphone reception — provided adequate volume control. Such an arrangement, however, results in several forms of distortion. The radio-frequency tube is necessarily operating at maximum amplification at all times, resulting in considerable overload of both that tube and the detector on strong signals. Backing up the regeneration control to reduce the signal strength results in additional distortion, due to the fact that the detector tube is then being operated with a decreased plate or screen voltage. The obvious solution is to employ a supplementary control at the input to the r-f stage.

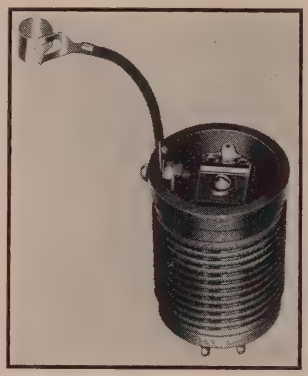
Under actual reception conditions, this volume control contributes several other advantages. The detector can always be operated on that portion of its characteristic curve at which best rectification is obtained, with a resulting improvement in tone quality and detecting efficiency. The receiver can also be operated in a condition of maximum selectivity on 'phone signals by setting the regeneration control close to the point of oscillation and controlling volume altogether at the r-f input. This latter feature is of particular utility in consideration of the congestion existing in the amateur telephone bands.

The volume control on

the SW-3 is arbitrarily calibrated from R-1 to R-9 — making possible accurate comparisons of signal strength in amateur and experimental reception.

R-F Transformers and Band Spreading

Following the policy of careful attention to all details of a simplified circuit in order to secure maximum performance, a special molding material was selected for the transformer forms. The use of this low-loss material permits the winding of the coil turns into grooves turned into the solid walls of the forms, resulting in a rigid transformer that will stand up under rough handling. This special molding material, known as "R-39," differs from the ordinary compositions in that it contains no wood flour or other moisture absorbing filler, the presence of which has been discovered by the Radio Frequency Laboratories to be the cause of the losses and variations in dielectric qualities of molded bakelite when placed in high frequency fields. As a result of the practical elimination of dielectric losses in the transformer field, not only is the sensitivity increased, particularly in the r-f stage where no appreciable amount of regeneration exists, but the selectivity is also improved due to the substantial reduction of the r-f resistance in the tuned circuits. In the case of transformers developed for the 33 to 20 mc range, it was found that the detector refused to oscillate when these coils were wound on forms molded of ordinary bakelite, whereas no difficulty was encountered when the special NATIONAL "R-39" low-loss material was used.



THE 7000-KC. BAND-SPREADING DETECTOR TRANSFORMER

A special six-prong form is used with the turns of the plate coil for the r.f. tube wound between the turns of the detector grid coil. The adjustment screw of the trimmer condenser is readily accessible from the top. The tickler winding is in a slot at the lower end of the form and the grid condenser and leak are inside, beneath the trimmer condenser.

While this receiver is so designed as to employ coil sets covering from 9 to 2000 meters, special band-spread coils have been developed in recognition of the SW-3's adaptability to amateur requirements. These coils are available for the 28, 14, 7, 3.5 mc as well as the 1.75 mc amateur bands.

In general appearance (as will be seen from the accompanying photographs) the new band-spread coils differ from the conventional coils only in that a lead comes out of the top which clips directly to the caps of the screen grid tubes, in place of the leads built into the receiver. In order that the clips in the receiver may not dangle about and short circuit on the metal chassis or cabinet, dummy insulating terminals are furnished for securing them safely.

Inside each detector coil form there is a small grid leak and grid condenser, as well as an adjustable low-capacity trimmer condenser. The schematic diagrams (Figures 1 and 2) show how the band-spreading is accomplished. Here it will be seen that C, the usual variable tuning condenser, now shunts only a portion of the total inductance, while the grid leak R and the condenser C connect directly to the top of the coil. Finally, the trimmer condenser C shunts this whole arrangement and is in parallel with the tube capacity, connecting directly from the grid to the filament. Figure 4 shows a sketch of the coil, indicating how the prongs of the coil are connected and the disposition of the screen grid lead which comes out of the top of the coil. The particular L/C ratio in this arrangement results in a circuit of a high order of sensitivity sufficiently superior to the conventional arrangement as to be readily detectable in listening tests.

Slightly different types of coils are used in the a-c and d-c models of the SW-3. Both types, in band-spread and standard designs, are described in detail, with wave ranges and identifications, in the catalog section of this booklet.

The advantages gained throughout the receiver by perfection of design have been conserved through the employment of low-loss dielectrics in the radio frequency circuits aside from the coil forms. The coil and tube sockets as well as the supporting bars for the variable condenser plates are of isolantite, an insulating medium that is consistently used wherever experimental research has indicated the advisability.

The Audio System

The output of the detector tube is impedance coupled to the single audio stage by means of a plate choke coil of very high inductive value. It was found that the use of a choke having a much higher inductance than the primary of a conventional transformer resulted in increased coupling efficiency, and the reduction of any tendency toward howling, roughness or backlash in the regeneration control. These difficulties were encountered to a highly objectionable degree when straight resistance coupling was employed.

Operation

As mentioned previously, an arrangement finding particular favor with many experienced amateur operators at this time is the use of a-c on only the heaters of the a-c tubes, so as to take

advantage of economical operating costs, "B" batteries being used for plate supply in preference to the so-called "B-eliminator." The operating advantage of such a combination shows up mainly on weak cw signals where a higher order of detector stability is obtained, due probably to the elimination of plate supply variations caused by line voltage fluctuations. It would also seem that there exists a slight increase in freedom from detuning effects of the regeneration control when using batteries in place of a simple power supply. The extent of this improvement, of course, depends upon the type of power pack involved and is much more noticeable when using the conventional type "B-eliminator" than when using a special type of power unit designed strictly for high frequency receiver operation.

The minor variations between the a-c and d-c models are indicated in the wiring diagrams, Figures 1 and 2. For a-c heater operation the circuit and tubes indicated in Figure 1 are used, with the plate supply furnished by a highly efficient eliminator. "B" batteries are not recommended because of the drain imposed by the voltage divider. When complete a-c operation is employed, it is most essential that the plate supply be well regulated and filtered. Where hum, instability or low sensitivity cast any suspicion on the available power source, it is recommended that a National Company, type 5880 AB unit be employed. This A-B power source is especially designed to supply heater and plate potentials for completely a-c operated short wave receivers. (A complete description of these units, for different line voltages and frequencies, will be found in the catalog section of this booklet.)

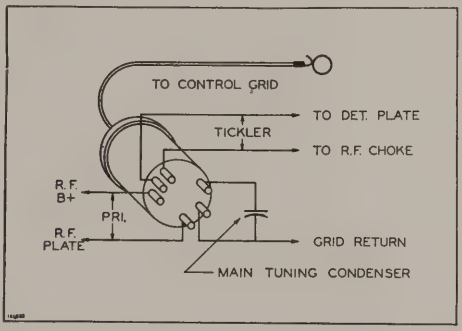


FIG. 4 — DIAGRAMMATIC EXPLANATION OF THE BAND-SPREAD COIL CONSTRUCTION

Band-spreading makes tuning and logging much easier, but does not affect the electrical separation of stations. Selectivity remains the same, except in so far as the more accurate tuning made possible by band-spreading, facilitates station discrimination.

The battery model, Figure 2 is designed to use either battery or a-c type tubes. When operated purely as a d-c receiver, the 6-volt 5-prong heater Type '36 and '37 tubes are recommended so as to permit operation from the standard 6-volt storage battery or "A" eliminator. As will be seen from the circuit diagram, a separate "B-minus" lead is brought out in the battery model. Thus the standard a-c tubes, also being of the 5-prong UY-base variety, may be plugged in at any time in place of the heater-type battery tubes and the receiver adapted to a-c operation.

When using the battery model of the receiver with the combination a-c & d-c power supply, a common center-tap resistor should be connected across the heaters inside the base of the chassis. It has been found that erratic operation will result on some frequencies unless this center tap resistor is placed across the heater terminals of one of the sockets, preferably the detector. If the receiver is to be used alternatively with a-c and d-c type tubes, provision should be made for removing this resistor from the circuit when operating with a filament battery so as not to impose a parasitic load on the batteries.

For complete battery operation, the 6-volt heater tubes were selected not only because of the convenient 5-prong base making them interchangeable with the a-c tubes and because of the general availability of 6-volt storage batteries, but also because of their freedom from the microphonic howls that occasionally cause trouble where the 2-volt type d-c tubes are employed.

There is of course no reason why the first audio stage of the SW-3 cannot be connected to a power amplifier for loudspeaker operation. Where an adequate amplifier is available, this receiver provides the most economical and efficient short wave receiving equipment. It can also be used in conjunction with the power supply and last stage channel of a high grade broadcasting receiver, and in such instances functions as a short wave "adapter."

The left hand control is the antenna trimmer, and the right hand control the regeneration-oscillation adjustment. The calibrated volume control is located just under the tuning knob.

For most effective results, the SW-3 should be operated in conjunction with a high grade short wave antenna, such as described in the National Company booklet "World Wide Short Wave Reception." (Sent for 10¢ in stamps, or free to the owner of any National short wave receiver.)

The compact size of the SW-3, measuring only 9¾" by 9" by 7", recommends it for portable, aircraft and other services where space and weight are important considerations.

Ham Language

AMATEUR and commercial operators employ a series of abbreviations in informal communication. Their use saves considerable time and effort, and stamps the operator as one of the initiate. These abbreviations, which in some forms resemble an altogether new language, represent several systems of shortening — the use of initials, first and last letters, the dropping of vowels, single letter homonyms, the substitution of the shorter code letter "i" for "y", numerical homonyms, simplified phonetic spelling and arbitrary abbreviations.

We publish below a list of the more common abbreviations for the benefit of those whose short wave experience has not been sufficiently extensive to have picked them up directly from the air, deciphered and committed them to memory. There are very many others of course, the following list showing only a few typical examples. These abbreviations are really a somewhat elastic variation of the Phillips code employed in the fast handling of telegraphic traffic, and should not be confused with the international radio abbreviations or "Q signals".

ABT	about
ACW	alternating current continuous wave
AGN	again
B	be
BC	broadcast
BCL	broadcast listener
BD	bad
B4	before
BT	but
BTTR	better
BUG	a high speed, semi-automatic transmitting key
CD (or CRD)	card
CL	call
CLD	called
CLNG	calling
CLR	clear
CN	can
CQ	a general call requesting a response
CRD (or CD)	card
C	see
CU	see you
CUAGN	see you again
CUD	could
CUL	see you later
CUM	come
CW	continuous wave
CY	copy
DA	day
DE	from
DLVD	delivered
DX	distance
DWN	down
ES	and
FB	fine business
FM	from
FLD	filed
FR	for
4	for
FRM	from
GA	go ahead, also good afternoon
GE	good evening
GM	good morning
GN	good night
GNG	going
GUD	good
GV	give
GVE	give
HAM	an amateur radio operator
HI	laughter
HM	him
HR	hear, here
HRD	heard
HV, HVE	have
HW	how
I	substitutes for letter Y
ICW	interrupted continuous waves
KNW	know
LTR	later
LTTR	letter
MANI	many
MI	my
MSG	message
ND	nothing doing
NG	no good
NW	now
NITE	night
OB	old boy
OG	old girl
OM	old man
OT	old timer
OW	old woman
OPR	operator
ORS	official relay station
OVR	over
1	one
PX	press
PLS	please
PSE	please
R	are
RU	are you —?
RCD	received
RDO	radio
RPT	repeat
RI	radio inspector
SFT	standard frequency transmission
SIG	signature
SIGS	signals
SINE	sign
SKED	schedule
SK	completion of communication
SORRI	sorry
SRI	sorry
SW	short waves
73	best regards
TFC	traffic
TKS	thanks
TNK	think
TNX	thanks
TMRRW	tomorrow
2	to, too and two
2mmrw	tomorrow
2DA	today
TR	there — also position or position report
TT	that
U	you
UR	your
URE	you're
VERI	very
VRI	very
WL	well, will
WRK	work
WDS	words
WRKNG	working
WV, WVE	wave
WX	weather
XMITTER	transmitter
XSTAL	crystal
YL	young lady
ARRL	American Radio Relay League
FONE	'phone or telephone

News from Short Wave Headquarters

The National Company has pioneered in the development and manufacture of short wave apparatus for the amateur, experimenter, broadcast fans and commercial users. The following items, from our general catalog (sent on request) are of particular interest to the users of the AC or DCSW-3.

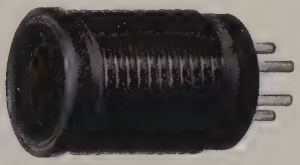
NATIONAL PLUG-IN TYPE INDUCTORS

These coils are of the plug-in type, providing the highest possible efficiency in short wave reception. They are wound on the famous low loss R-39 insulating material.

Coils for The ACSW-3
(using '58 type tubes)

Catalog Symbol	*Range*	*List Price Per Pair*
No. 60	9. to 15. meters	$5.00
No. 61	13.5 to 25. meters	5.00
No. 62	23. to 41. meters	5.00
No. 63	40. to 70. meters	5.00
No. 64	65. to 115. meters	5.00
No. 65	115. to 200. meters	5.00
No. 66	200. to 360. meters	5.50
No. 67	350. to 550. meters	5.50
No. 68	500. to 850. meters	6.50

The above coils of the "60" series are also designed for use in the new ACSW-58 which employs the 58 type tubes.



Coils for The DCSW-3

The coils listed below are designed especially for use in the original AC and DC 3-tube Amateur Receivers, the ACSW 5, ACSW 45, DCSW 5 and the new DCSW 34 Short Wave Thrill Boxes, as well as the new DCSW 3.

Catalog Symbol	*Color*	*Range*	*List Price Per Pair*
No. 10	Brown	9. to 15. meters	$5.00
No. 11	Black	13.5 to 25. meters	5.00
No. 12	Red	23. to 41. meters	5.00
No. 13	White	40. to 70. meters	5.00
No. 14	Green	65. to 115. meters	5.00
No. 15	Blue	115. to 200. meters	5.00
No. 16	Orange	200. to 360. meters	5.50
No. 17	Yellow	350. to 550. meters	5.50
No. 18	Purple	500. to 850. meters	6.50
No. 19		850. to 1200. meters	8.00
No. 20		1200. to 1500. meters	8.00
No. 21		1500. to 2000. meters	8.00

Forms only — 4-prong UX base ..... ea. $.75
5-prong UY base ..... ea. .75
6-prong Special ..... ea. .75
Socket only — 4, 5, or 6-prong Special made of Isolantite ea. $.60

Special AMATEUR Coils

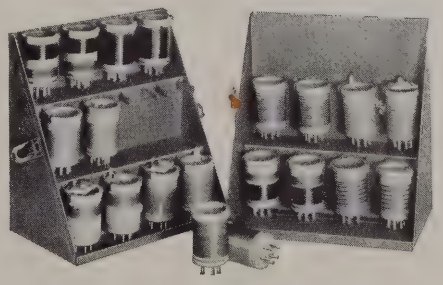
These coils are designed so as to permit 50 dial division spreading on the amateur 20, 40, 80 and 160 meter bands, using the standard NATIONAL SW Thrill Boxes.

The Band Spread coils are available in both the "10" and the "60" series. Be sure and order the "60" series if the receiver with which the coils are to be used employs the 58 type tubes. If the receiver does not use the 58 tubes, then order the "10" series.

No. 11A — 20 meter band (per set of 2) $5.00
No. 13A — 40 meter band (per set of 2) 5.00
No. 14A — 80 meter band (per set of 2) 5.00
No. 15A — 160 meter band (per set of 2) 5.00

No. 61A — 20 meter band (per set of 2) $5.00
No. 63A — 40 meter band (per set of 2) 5.00
No. 64A — 80 meter band (per set of 2) 5.00
No. 65A — 160 meter band (per set of 2) 5.00

NATIONAL Coil Cabinet



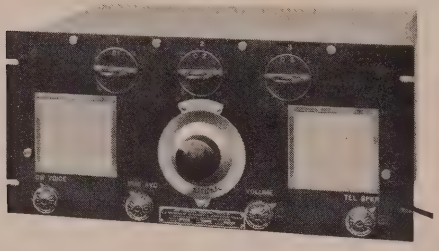
A convenient way of keeping the extra coils when not in use in the short wave receiver is in a National Coil Cabinet. When open, the coils are all in full view so as to facilitate the ready selection of the desired pair. The two halves of the cabinet fit together so as to form a compact unit measuring approximately 9 inches by 8 inches by five inches when closed. Made of heavy gauge steel and finished in durable attractive brown moiré. On the front of the cabinet is a receptacle for the calibration curves.

National Coil Cabinet. . . . . List price, **$3.75**

NATIONAL SHORT WAVE RECEIVERS

The AGS Communication Type

Developed in conjunction with the Airways Division of the U. S. Department of Commerce. Superheterodyne circuit with front panel plug-in coils.



Catalog Symbol — *Description*

AGS — National Type AGS Short Wave Receiver completely wired and Laboratory tested, with coils to cover Frequency Range 20,000 to 1500 kc. (less tubes)

List Price **$265.00**

The 58C Communication Type

A modification of the highly efficient ACSW-58 and DCSW-34, arranged with a vernier dial and for coil change from the front of the panel. Desk or relay rack mounting.

Catalog Symbol — *Description*

58C — National Type 58C Short Wave Receiver completely wired and Laboratory tested with coils to cover frequencies of from 2.6 MC to 22MC. (less tubes)

List Price **$120.00**

The ACSW-58 and DCSW-34

These receivers are of the highest type designed for experimental and amateur use and are described fully in the booklet entitled "World Wide Short Wave Reception" listed on page 15 of this booklet. The ideal type of receiver for reception of international short wave broadcasting stations. Furnished with five sets of coils to cover range of 13.5 to 200 meters.

Catalog Symbol

ACSW-58 National complete set of parts for 5-tube AC 58 Short-Wave Receiver, less tubes

List Price **$79.50**

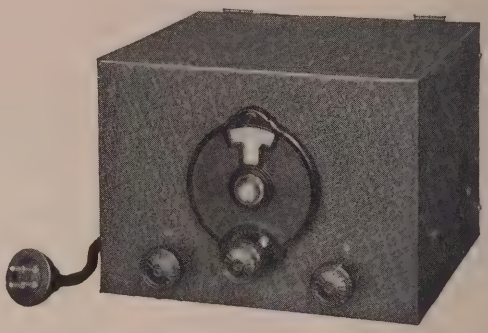
DCSW-34 National complete set of parts for 5-tube DC Short-Wave Receiver, less tubes

List Price **$75.00**

We can have any of the above sets of parts wired for you by Jackson Research Laboratories at an additional list price of

List Price **$10.00**

The SW-3, Three Tube Thrill Box



A highly efficient and popular receiver for amateur use, with telephone receiver output. The choice of leading amateurs the world over.

Catalog Symbol — *Name of Parts*

ACSW3 NATIONAL complete 3-tube Short Wave Thrill Box — less coils — less tubes — wired by the Jackson Research Laboratories. . . . . List Price **$29.50**

NOTE: The above price is for either AC or DC models. When DC Battery model is desired, specify Catalog Symbol as DCSW3.

The coils for the SW3 are listed on page 11.

NOTE

On Page 15 of this booklet is a list of National Company's Engineering Bulletins, describing the ACSW-58, DCSW-34, and the "AGS" Communication receivers in much the same style as this booklet describes the SW-3.

The ACSW-58 and DCSW-34

Ultra High Frequency Receiver and Converter

The ultra high frequency receiver, type HFR is of the superheterodyne type and is supplied with four sets of coils covering the 40–75 megacycle band (approximately 4 to 7.5 meters). For beatnote and phone reception. High signal to noise ratio. (Not illustrated.)

The HFR Superheterodyne makes a very fine amateur 80-meter phone band receiver, when used with the special coils available for this purpose. When so used the receiver is extremely easy to operate, highly selective and spreads the band over essentially the entire dial scale. Coils are also available for use with the HFR receiver on the 20- and 40-meter amateur bands. List price per set of coils for the 20- or 40-meter bands, $2.50, and for the 80-meter band, **$3.50**

The ultra high frequency converter, type HFC utilizes the features of the type HFR receiver, and is designed to operate in conjunction with any efficient broadcast receiver.

This Converter illustrated below spreads the amateur 5-meter band over a large percentage of the dial scale. Coils are also available for the 20-meter band and the 80-meter phone band. The list price of the 20-meter coils is $2.50 per pair, and the 80-meter phone band coils, per pair, **$3.50**

Catalog Symbol

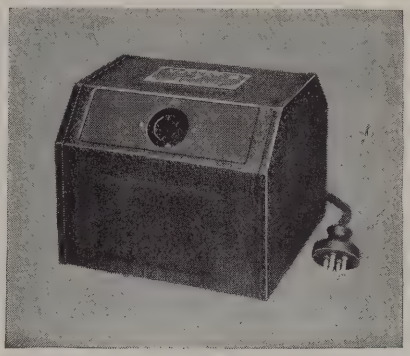
HFR — Complete set of parts (Completely wired) with (4 sets of coils) less tubes and power supply..... **$89.50**

The above set of parts is not available for assembling a battery operated model.

Type HFC-58 Converter. Complete set of parts (Completely wired) in Metal Cabinet less tubes..... **$39.50**

National Short Wave Power Supply Units

These power units are designed to operate the short wave receivers described above, at their highest efficiency. Compact, foolproof and reliable.



Catalog Symbol *Description*

5880-AB Completely wired power supply for use with the ACSW3 Thrill Box. Amateur receiver on 105–120 volts, 50–60 cycle current supply. Less tube.....List Price **$26.50**

5880-AB-25 Completely wired power supply for use with the ACSW3 Thrill Box. Amateur receiver on 105–120 volts, 25–40 cycle current supply. Less tube.....List Price **$39.50**

5880-AB-220 Completely wired power supply for use with the ACSW3 Thrill Box. Amateur receiver on 220–230 volts, 50–60 cycle current supply. Less tube.....List Price **$37.00**

5880-AB-S Completely wired power supply for use with the ACSW45 and 58 Thrill Box using the '45 tubes in the output stage on 105–120 volts, 50–60 cycle current supply. Less tube.....List Price **$39.50**

5880-AB-S25 Completely wired power supply for use with the ACSW45 and 58 Thrill Box using the '45 tubes in the output stage on 105–120 volts, 25–40 cycle current supply. Less tube.....List Price **$42.50**

5580-AB-S220 Completely wired power supply for use with the ACSW45 and 58 Thrill Box using the '45 tubes in the output stage on 220–230 volts, 50–60 cycle current supply. Less tube.....List Price **$39.50**

3258 AB — Completely wired. AB power supply designed especially for Type HFR receiver listed above. RCA licensed (less tube) **$39.50**

VELVET-B Type 3580 —

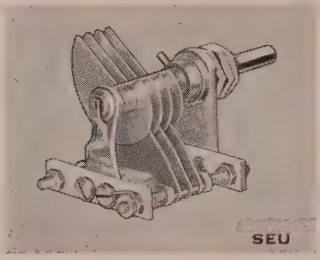
A NATIONAL B-Eliminator designed for reliable service. Operates 1 to 6-tube sets, including power tube.

This rugged unit has been designed with liberal factors of safety in all component parts.

Provided with Protective Voltage Adjustments Silent, Hum-free Output List price, less tube..... **$16.50**

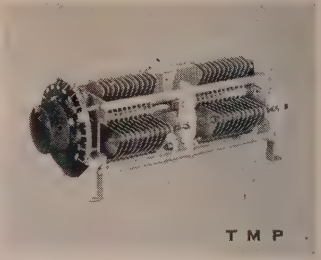
Use these NATIONAL Products *When you Build* SHORT WAVE

When you build a short-wave receiver or transmitter — get the maximum efficiency and performance with these NATIONAL parts, designed for short-wave use. NATIONAL Company, pioneer in the radio field and in the manufacture of electrical apparatus since 1914, has developed a full line of parts for ultra short-wave use in its Research Laboratories. Some of these are shown below. The full NATIONAL Company line of the famous Velvet Vernier Dials, Variable Condensers for Receiving and Transmitting Use, Transformers — RF, Audio and Power, Tube Shields, SW-58 and SW-3 Short-Wave Receivers, NC-5 Short-Wave Converter, Ultra High Frequency Receiver HFR (5 meters), Ultra High Frequency Converter HFC, Communications Type Receivers AGS and 58C, MB-32 DeLuxe Broadcast Tuner, Speaker Amplifier and Power Supplies, are all shown in the new NATIONAL 18-page Bulletin No. 200.



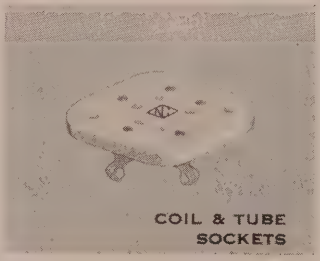
SEU S-W CONDENSER

For short-wave work only. Heavy double-spaced, rounded edge 270° plates, insulated front bearing, constant low impedance, pigtail, Isolantite insulation, single hole panel or base mounting. Any capacity up to 25 mmf. For ultra short-wave tuning or neutralizing in low power transmitters.



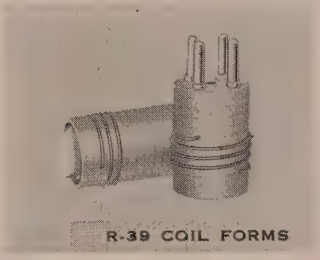
NATIONAL SOCKETS

Isolantite tube and coil sockets, glazed upper surface, give maximum efficiency in ultra high frequency circuits, suitable for sub-panel or baseboard mounting, available in standard 4, 5, 6 and 7 pronged types.



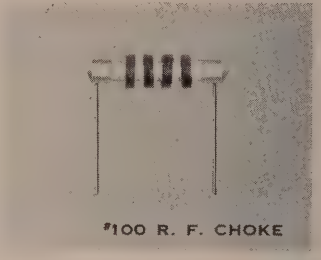
TYPE TMP
Transmitting Condenser

Split-stator type, for medium power push-pull transmitters. Fine for 5-meter work — give extremely accurate balance between both sides of tank coil. Heavy polished plates, rounded edges, self-aligning conical bearings, rigid frame construction, 3000 and 6000 volts.



MIDGET R-39 COIL FORMS

Made of improved R-39, low-loss ultra HF material. Have best form factor for ultra S-W work and lowest power-factor, insure stability, maintain calibration. Also available in larger size with either 4, 5 or 6-prong for regular short-wave use.



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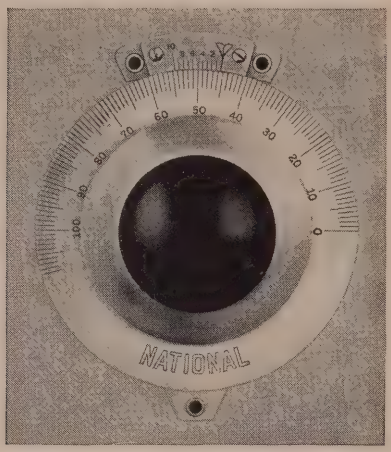
7. The "AGS," a De Luxe High Frequency Communication Receiver
8. An investigation into Single Signal Reception

*Temporarily out of print

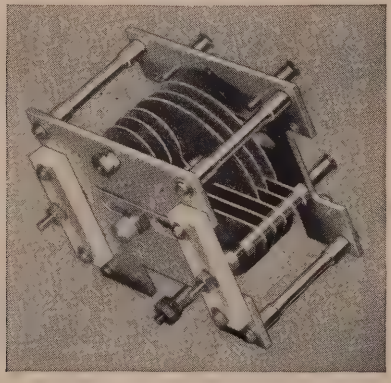
ACCURATE FREQUENCY METERS DEMAND ACCURATE EQUIPMENT



4-INCH TYPE N VELVET-VERNIER DIAL

Solid German Silver, All Divisions Engraved

For maximum precision of operation, this NATIONAL type N Dial is being used more and more by amateurs and experimenters in receiving and transmitting equipment, frequency meters, etc. Engraved flush-vernier gives exact readings to 1/10 dial division. Insulated flexible hub-coupler assures permanent accuracy by taking all strain off dial itself, and at the same time insulates exposed metal parts of dial from the shaft. The original and matchless NATIONAL Velvet-Vernier Mechanism is used, of course, but with materially increased driving power, so that drive-slip is practically impossible. (National Co. Inc. makes a complete line of dials of all types. Protected by U. S. Patent Nos. 1,744,675, 1,653,875, 1,656,532, 1,713,146. Other patents pending.)



Type 40–75 — Frequency Meter Condenser

This special condenser is designed for use in amateur frequency meter and monitor circuits. Adapted for use in High-C circuits, thus avoiding changes in calibration which would otherwise arise from differences in tube characteristics, temperature, etc. Spreads 160 and 80 meter bands over 80 divisions with 100 division dial. Min. cap. 40 mmf., max. cap. 75 mmf.

Write for the new National Company 18-page catalogue.

NATIONAL COMPANY INC.

61 Sherman Street **Malden, Mass.**

RP 5-M—5-34
Printed in U.S.A.

A COMBINATION A.C. AND D.C. AMATEUR-BAND RECEIVER

— BY —

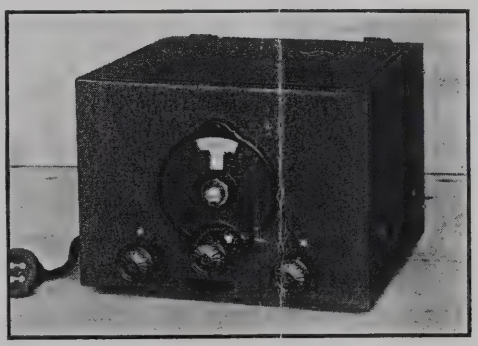
JAMES MILLEN, M.E.

Reprinted by Courtesy
Q. S. T.

A Combination A.C. and D.C. Amateur-Band Receiver

By James Millen, W1AXL*

THE advent of the 1931 crop of new tubes served to open up wider horizons in high-frequency receiver design than the tube and b.c. set manufacturers' advertisements would lead one to believe. The characteristics of several of the new types of tubes are such as to satisfy very nicely some of the requirements peculiar to amateur-band frequencies that were not so well taken care of by the tubes available in the past. Specifically, in the realm of a.c. type detectors, the new Type '35 variable-mu provides a real solution of the regeneration control problem when using grid-leak detection; while the heater type '36 and '37 tubes wipe out the microphonic and other troubles that beset the d.c. receiver previously restricted to using the notoriously noisy '22's and '01-As. Still better, the coming of these d.c. heater type tubes, with their UY bases, has made possible the design of a single receiver that can be used optionally as an a.c. or d.c. set without making a major change in its internal connections. Where the appropriate heater type tubes are employed alternatively for either a.c. or battery operation, the same self-biasing resistors, by-pass condenser arrangement and other such circuit details, that generally vary so widely in the two types of receivers, become identical.



SINGLE-CONTROL TUNING OF TWO TUNED CIRCUITS

Band spreading, calibrated volume control, complete shielding and adaptability to either a.c. or battery operation are the salient features of this receiver. The "set and forget" antenna trimmer control is at the left and the regeneration control at the right, with the operating edge of the calibrated volume control disc immediately below the main tuning dial.

Although little over a year ago a.c. operation of an amateur-band receiver was generally considered rather impractical by the amateur fraternity, the readily recognized superiority of a.c. tubes over the battery type resulted in such an accelerated development of the a.c. receiver that it was not long before the problems of a.c. operation were rather well mastered and the use of a.c. operated receivers became pretty well recognized as standard practice.[1]

In recent months, however, an increasing number of experienced operators has been switching to the use of combination a.c. and battery operated receivers. It is well known that unless an unusually high quality power pack is employed for the completely a.c. operated high-frequency receiver, it is generally found that the combination of a.c. filament heating and battery plate supply results in a steadier reception when receiving weak c.w. signals with an oscillating detector. Possibly this may be due to the isolation of the two sources of power supply, or perhaps merely to the elimination of fluctuations in the plate supply voltage caused by minor variations in the line voltage. Regardless of the exact reason, it must be admitted that battery plate supply is an improvement under some receiving conditions.

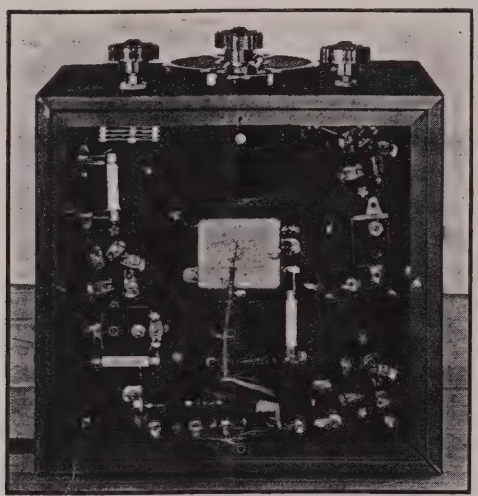
The life of the "B" batteries will be long, with the usual few milliamperes drain demanded by a three-tube set, and the first cost of the filament transformer and 135-volt block of batteries will be considerably lower than that of a high grade "r.a.c." supply designed for satisfactory high-frequency receiver work. There is also another advantage to the use of "B"-battery plate supply; and that is the complete elimination of that slight trace of regeneration-control "detuning effect" generally encountered to at least some degree in all completely a.c. operated ham receivers. Probably it is the superior "regulation" characteristic of "B" batteries that overcomes the trouble but, in any event, the combination a.c. filament supply "B"-battery plate supply type of operation seems to be as free from such trouble as when the receiver is entirely battery operated.

For complete battery operation the new 6-volt d.c. heater type tubes are far superior to any others previously available for such work. Gone are all the noises, microphonics, and other such troubles of former battery tubes. Also, the heater being designed for 6-volt operation restores to use the storage battery or "A" eliminator generally to be found in every amateur station.

* The National Co., Malden, Mass.

[1] Kruse, "Revising Amateur Tuner Design," *QST*, Janu-

herewith, the total current consumption at six volts is under one ampere. Unfortunately, however, at this writing a variable-mu screen grid battery tube has not as yet made its appearance, but no doubt when the advantages of the Type



THE UNDERSIDE OF THE A.C. MODEL WITH ITS BASE-PLATE REMOVED

'35 become more generally realized, a companion battery tube will also make its appearance.

Of course there is always a demand for a d.c. receiver from those who must operate in localities where there is no a.c. available, and now with the new heater-type battery tubes it is possible to design a battery receiver of similar characteristics to the a.c. models. Thus the amateur in the rural districts, as well as those on exploration parties, expeditions, etc., may have essentially the same type of set as their brother operators located in the a.c. districts.

GENERAL DESIGN OF THE RECEIVER

The peculiarities of amateur reception, both c.w. and 'phone, seem to be such as to make headsets preferable to loud speakers. For this reason there is little point in equipping the typical ham receiver with a power output stage; a single stage of a.f. amplification is ample. Such is particularly true when the detector is of the screen-grid type and preceded by an r.f. stage that actually has some gain.

As has been discussed in detail in the article previously referred to, the screen-grid type of tube, combined with certain design essentials, has made possible an r.f. stage that actually has real gain all the way up to 50 megacycles, and perhaps higher. The new '35 variable-mu tube, with its lower plate impedance, makes possible the further increase in gain from the r.f. stage of the a.c. set,[2] and the similarly low plate impedance of the Type '36 screen-grid tube gives a corresponding advantage for the d.c. receiver.

While the combination of a single high-frequency stage and a regenerative screen-grid detector is not so selective as a double-detection or superheterodyne arrangement, it is equally as sensitive as any such receiver and has a very definitely better "signal to noise" ratio. This one feature alone should justify the one r.f. stage and screen-grid detector combination, in preference to a number of more elaborate circuits with their marked shortcomings in this respect.

Aside from the value of the gain obtained from the single audio stage, it serves as a very essential coupling medium between the output of the detector and the headphones, so as to insure smooth regeneration, freedom from fringe howl and back-

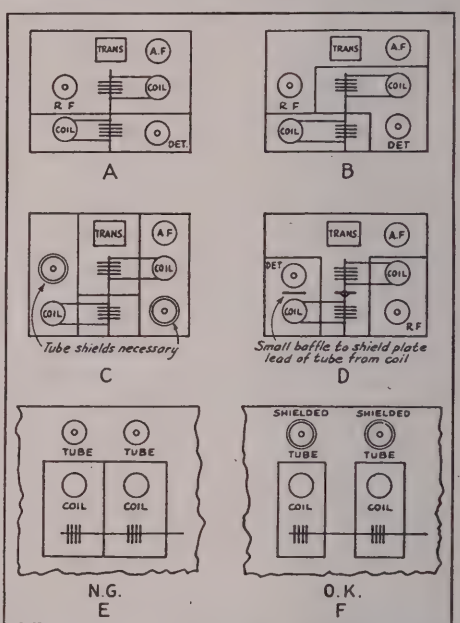


FIG. 1 — SHIELDING ARRANGEMENTS, GOOD AND BAD

That shown at D is used in the receiver described.

lash, as well as the elimination of undesired feedback from the 'phone cord to the input circuit of the receiver. Then again, the audio stage makes possible the calibrated attenuation control of which more will be said later.

SHIELDING

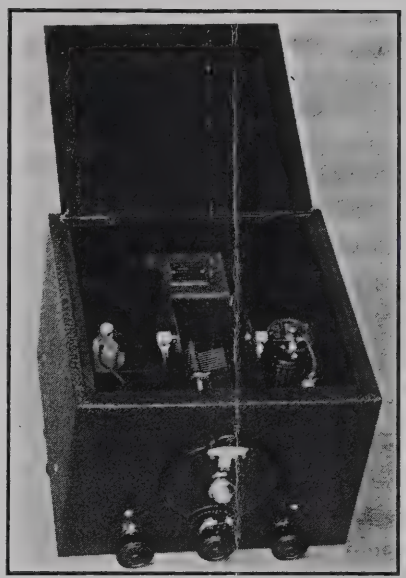
While it would seem that the single stage of r.f. and regenerative detector type of circuit is about as simple an arrangement to build as can be imagined, such has been found far from true where just more than mediocre performance is

[2] Grammer, "The Variable-Mu Tetrode," *QST*, May, 1931.

demanded. Take, for instance, the shielding; if it is not serving its purpose, the r.f. tube will oscillate whenever the detector regeneration control is advanced. This condition exists to a surprising extent in both homemade and commercial receivers in use to-day. Such receivers are tolerated, it would seem, simply because the owners have never operated a properly functioning receiver employing the same circuit *properly shielded.* There just isn't any comparison.

The mere fact that the r.f. stage is apparently stable when the detector is approaching an oscillating condition is not necessarily an indication of perfect shielding, as "interlocking" still may be present to a most obnoxious degree. There is, moreover, far more to shielding than the mere boxing off of the different parts of the circuit. Take, for example, the receiver being described. If you were starting to design such a job, wouldn't you try an arrangement as shown in Fig. 1A? At least, that is what we did, and the results were most disappointing. At first thought, this seemed an ideal arrangement because the coils, tubes and condensers of the two circuits were completely shielded from each other. It was found that with a "watertight" joint between the shield and the base there was no oscillation trouble with the r.f. amplifier, although there was an annoying amount of tuning interlocking. As soon as the chassis was put in a metal cabinet, however, and the cover closed, the r.f. stage oscillated violently!

Next tried was the arrangement shown at *B* in Fig. 1, but here the results were not even so satisfactory as the previous arrangement. Furthermore, the lack of symmetry of the shielding made it very difficult to gang the r.f. and detector tuning condensers.



WITH THE COVER OPENED

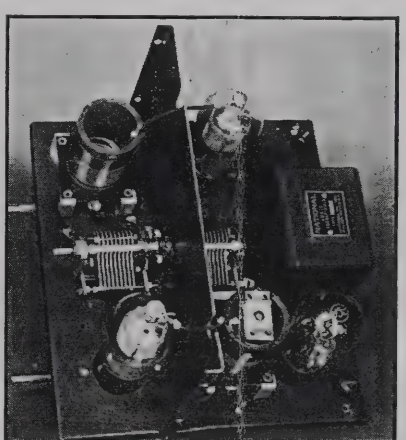
The plan of the internal arrangement is the same as that shown at D in Fig. 1. With the band-spreading coils in place, the normal control-grid clips fasten to the dummy insulating plugs mounted on the compartment walls. The partitions are welded to the sides of the cabinet but are insulated from the base by an air gap.

The next attempt was as shown at *C* in Fig. 1. This arrangement worked fairly well in comparison with its predecessors, but here, too, there was still excessive interaction. Perhaps the compartments were so large that the shielding effect was nowhere near complete since the effect of isolation of the coil compartments decreases very rapidly as the compartment size increases. Another disadvantage of this arrangement was the requirement of tube shields. There was, however, no detrimental effect when the chassis was placed in a metal cabinet.

After the experience gained with models *A*, *B* and *C*, we were able to arrive at the arrangement as illustrated at *D*. Here the compartments were small enough to properly shield and yet large enough so as not to increase the coil losses appreciably. Furthermore, there was no common partition between the coil compartments as had existed in models *A* and *B;* and which, no doubt, was responsible for the "cover" effect. The small baffle between the r.f. tube base and the coil was found essential in order to shield the plate lead and prevent oscillation.

In the final model it was found advantageous to make the vertical parts of the shielding integral with the metal cabinet rather than to weld them directly to the chassis. It was found also of further advantage to insulate the vertical parts of the shielding compartments from the chassis itself with a $\frac{1}{8}''$ air gap and to weld them very thoroughly to the sides of the metal cabinet. The chassis, in turn, is grounded to the cabinet by several mounting screws on each side. Such an arrangement completed the shielding job by reducing interlocking to a negligible degree.

A further indication of the trouble to be experienced in attempting to use



A GOOD EXAMPLE OF HOW NOT TO SHIELD

A study of shielding in the development of the receiver described brought out some surprising points. The example illustrated looks good but isn't, as explained in the text. This arrangement is the same one shown at A in Fig. 1.

a common partition between the coils in a short-wave receiver is illustrated at *E* and *F* in Fig. 1. This problem was recently encountered in the design of another receiver employing the same circuit. The separate compartments completely eliminated the r.f. oscillation and interlocking difficulties.

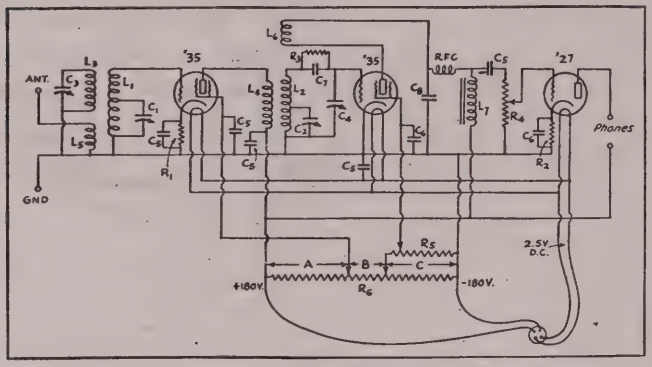


FIG. 2 — THE ALL-A.C. VERSION OF THE RECEIVER

L_1, L_2, L_3, L_4, L_5 and L_6. See table of r.f. transformer specifications.
L_7 — 750-henry plate coupling reactor. A good audio transformer with primary and secondary connected in series might be used.
C_1 and C_2 — 90-μμfd. ganged tuning condensers with insulating shaft coupling.
C_3 — Midget type trimmer condenser.
C_4 — 8-μμfd. detector transformer trimmer condenser (incorporated in coil form), Hammarlund No. 35.
C_5 — .01-μfd. non-inductive mica fixed condensers.
C_6 — .5-μfd. non-inductive paper fixed condensers.
C_7 — 100-μμfd. mica grid condenser, small type. Incorporated in detector r.f. transformer.
C_8 — 250-μμfd. mica by-pass condenser.
R_1 — 500-ohm cathode resistor, 2-watt type.
R_2 — 2000-ohm cathode resistor, 2-watt type.
R_3 — 5-megohm grid leak, one in each detector transformer.
R_4 — 500,000-ohm calibrated tapered type potentiometer. See text.
R_5 — 50,000-ohm regeneration control potentiometer.
R_6 — B-voltage divider, total resistance 12,000 ohms divided as follows: A, 6900 ohms; B, 2000 ohms; C, 3100 ohms.

STEEL *VS.* ALUMINUM

Perhaps a word regarding our experiences with steel and aluminum as shielding material also might be of interest at this point. It is only too well known that on the extremely low frequencies, say for instance 60 cycles, iron is definitely better as a magnetic shielding material than aluminum. As the frequency increases, however, this difference rapidly diminishes until at broadcast frequencies it has practically completely disappeared; and from then on up, from a purely shielding point of view, there appears little, if any, actual difference.

But there are several other aspects to be considered additional to the pure shielding effect. One of these is the introduction of losses when shielding is placed close to a coil. It is for this reason that in the design of the receiver care has been taken to keep the steel shielding partitions everywhere separated from the r.f. transformers by distances at least equal to the coil diameter. At this, or greater distances, there seems to be no noticeable difference in the resistance of the r.f. transformers whether the shielding be aluminum or steel. In the design of receivers where it is necessary to place the shield closer than the diameter of the coil at any point, then there is a marked advantage in using aluminum or some other non-ferrous material.

In high frequency work, our present concern, the real advantage of the use of steel over aluminum lies in its shielding of the receiver as a whole from the low frequency (60-cycle) magnetic field which generally so completely envelops the ham operating table and which, in many cases, results in a strong a.c. hum in connection with aluminum shielded battery type receivers. Then, of course, there is the matter of the so-called "water-tight" shield joints, which are so hard to obtain with aluminum and so easy to obtain commercially by welding with steel or by soldering with copper.

GANGING

At the present state of the radio art there is no excuse for a 2-condenser type receiver that is not truly single-dial control in the fullest sense of the term. In the present receiver, such control is obtained by the mounting of the two tuning condensers in tandem by means of a flexible insulating coupling unit.

The trimmer condenser, C_3, shown in the diagram and photograph is not an auxiliary tuning control to be juggled along with the main tuning dial. It is for the sole purpose of supplying the varying amounts of capacity "padding" required with the different transformers. This capacity well might be incorporated in the transformer itself if it were not for the unknown capacity-loading effect of the antenna system. Therefore, it is merely necessary to set the trimmer whenever a pair of r.f. transformers is plugged in and then not touch it until the transformers are replaced or a different antenna is connected. Many operators determine the proper adjustment of this trimmer condenser by adjusting for maximum background noise but a more accurate way is to adjust the trimmer for the point of minimum setting of the regeneration control that will produce oscillation in the detector circuit.

The two tuning condensers are of the same maximum capacity, namely, 90 μμfd., and are of the straight-frequency-line type with 270° rotation. This latter feature gives a 50% greater spread of the tuning range for a given set of transformers; or, conversely, for a given degree of

criticalness of tuning it reduces by 50% the number of coils required to cover the entire frequency range from 33 mc. to 1500 kc. While it might seem that a more compact and better mechanical arrangement would be the employment of a special single unit 2-gang condenser, such has proven not to be the case. It was found that even though the frames of the two separate condensers were grounded to the main chassis, the breaking of the common shaft by means of the insulated flexible coupling unit, in the manner illustrated, was a very important factor contributing to the complete elimination of the natural tendency of the r.f. stage to interlock and oscillate when the detector was thrown into oscillation by the regeneration control. In a specially constructed single unit, 2-gang condenser, using the same general type of design as employed in the individual condensers but having a common shaft, it was found that while shielding partitions would eliminate the greater part of this interlocking tendency, there was always a trace left that could not be completely cured.

The special mechanical features of the condensers, such as the insulated main bearings (to eliminate the shorted turn effect of the frame), the constant impedance pigtail and the special insulation material have already been described in detail in *QST* in the article to which there has been previous reference.

R.F. TRANSFORMERS AND BAND-SPREADING

Following the policy of careful attention to all details of a simplified circuit, in order to secure maximum performance a special molding material was selected for the transformer forms. The use of this low-loss material permits the winding of the coil turns into grooves turned into the solid walls of the forms, thus resulting in a rigid transformer that will stand up under quite rough handling. This special molding material, known as "R-39," differs from the ordinary in that it contains absolutely no wood flour or other moisture absorbing filler, the presence of which has been discovered by the R.F.L. people to be the cause of the losses and variations in dielectric qualities of molded bakelite when placed in high frequency fields.[3] As a result of the practical elimination of dielectric losses in the transformer field, not only is the sensitivity materially increased, particularly in the r.f. stage where no appreciable amount of regeneration exists, but also the selectivity is improved due to the very substantial reduction of the r.f. resistance of the tuned circuits. In the case of the transformers that were developed for the 33- to 20-mc. range, it was found that the detector refused to oscillate when these coils were wound on forms molded of ordinary bakelite, whereas no difficulty whatsoever was encountered when the special "R-39" low-loss material was used in the same molds for making the forms for this range.

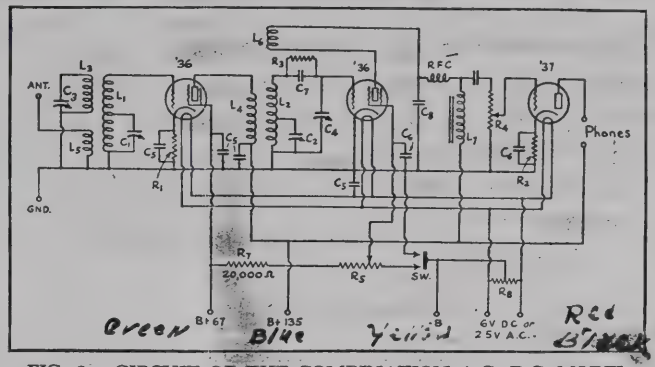


FIG. 3 — CIRCUIT OF THE COMBINATION A.C.-D.C. MODEL

Specifications are identical with those of Fig. 2, with the following exceptions:
R_7 — 20,000-ohm 2-watt type resistor.
R_8 — 50- or 100-ohm filament center-tap resistor, necessary only with a.c. filament supply.
SW — Regeneration control and cathode circuit switch.

While this new receiver is so designed that any of the standard six-prong transformers developed originally for another receiver [1] may be used with it in order to cover the range from 33 mc. to 350 kc., since it has been designed primarily for amateur work it has a special set of band-spread transformers as standard equipment. The three pairs of band-spread transformers are for the 14-, 7- and 3.5-mc. amateur bands. In general appearance, as will be seen from the accompanying photographs, the new band-spread coils differ from the conventional coils only in that a lead comes out of the top for clipping directly to the cap of the screen grid tube, in place of the lead built into the receiver. In order that the clips in the receiver may not dangle about and short circuit on the metal chassis or cabinet, dummy

R.F. TRANSFORMER SPECIFICATIONS

Winding	*14,000-kc. Band*	*7000-kc. Band*	*3500-kc. Band*	*Size Wire*
L_1 and L_2	10 t.	21 t.	35 t.	No. 22 Enam.
Tap, turns from bottom	2¼	5¾	16¾	
L_3 and L_4	8 t.	16 t.	22 t.	No. 34 d.s.c.
L_5 and L_6	3 t.	4 t.	4 t.	No. 34 d.s.c.

R.f. and detector stage transformers are identical except that a grid leak, grid condenser and trimmer condenser are incorporated in each detector transformer. The grid leaks are each 5 megohms, the grid condensers each 100 μμfd. and the trimmer condensers each approximately 8 μμfd. The plate winding (L_3 or L_4) is wound between the turns of the grid winding (L_1 or L_2), starting at the bottom of the coil. Additional details are given in the text.

[3] Kruse, "A Multi-Range Receiver," *QST*, October, 1930.

insulating terminals are furnished for fastening them out of the way.

Inside each detector coil form there is a small grid leak and grid condenser, as well as an adjustable low-capacity trimmer condenser. The schematic diagrams of Figs. 2 and 3 show how the band-spreading is accomplished. Here it will be seen that C_2, the regular variable tuning condenser, now shunts only a portion of the total inductance while the grid leak R_3 and the condenser C_7 connect directly to the top of the coil. Finally, the trimmer condenser C_4 shunts this whole arrangement and is in parallel with the tube capacity, connecting directly from the grid to the filament. Fig. 4 shows a sketch of the coil, indicating how the prongs of the coil are connected and the disposition of the screen grid lead which comes out of the top of the coil. The particular L/C ratio in this arrangement results in a circuit of a high order of sensitivity; sufficiently more so than with the conventional arrangement as to be readily detectable by listening tests.

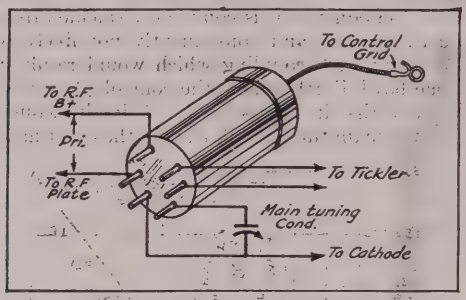
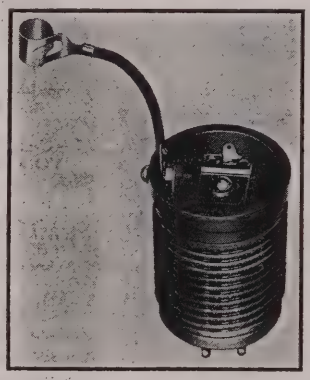


FIG. 4—A SPECIAL SIX-PRONG BASE AND A FLEXIBLE LEAD ARE NECESSARY FOR THE SEVEN CONNECTIONS TO EACH R.F. TRANSFORMER

Full constructional details are given in the table of transformer specifications. In all three sets of transformers the grid winding has its turns spaced so that the length of winding is equal to the diameter. The primary or plate winding is then wound between the turns of the grid winding, starting from the "ground" end and working up approximately two-thirds of the way toward the grid end. The location of the tap for the tuning condenser must be accurate to the fraction of a turn indicated in order to spread the particular band over approximately 75 dial divisions. The tickler or antenna coil is wound in the slot at the bottom of the coil form and the center of this slot is located approximately ¼-inch below the end of the grid winding.

The value of approximately 8 $\mu\mu$fd. for the trimmer condensers given in the table is the capacity at which the condensers are set when in normal use. The particular condensers used for this purpose are the standard Hammarlund Type No. 35.



THE 7000-KC. BAND-SPREADING DETECTOR TRANSFORMER

A special six-prong form is used with the turns of the plate coil for the r.f. tube wound between the turns of the detector grid coil. The adjustment screw of the trimmer condenser is readily accessible from the top. The tickler winding is in a slot at the lower end of the form and the grid condenser and leak are inside, beneath the trimmer condenser.

VARIABLE-MU REGENERATIVE DETECTOR

From a purely circuit point of view, one of the several outstanding features of the all-a.c. version of the receiver lies in the use of the Type '35 variable-mu tube as a regenerative detector. Perhaps the reasons that intrigued us into the investigation of the possibilities of the '35 as a high-frequency regenerative detector was the statement made on the data sheets supplied with the tubes, to the effect that their use as detectors was not recommended, plus George Grammer's story on this tube in the May issue of *QST*, in which he intimated that while perhaps the tube manufacturers were right with reference to the use of the '35 as a plate detector, it certainly ought to make a good grid detector. Numerous investigations and experiments during the past few months have borne out this theory.

From past experience in designing high-frequency receivers employing the Type '24 screen-grid tube as a regenerative grid detector, it had been found that of the various methods of regeneration control the most satisfactory was the variation of screen voltage by means of a potentiometer. But how would the action of the '35 tube as a grid detector differ from the '24 when its screen voltage was shifted? For some unknown reason the tube manufacturers in their data sheets and their "engineering and specification reports," as supplied to the radio set manufacturers, seem to be surprisingly consistent in at least one respect; namely, the complete omission of any curves that might throw some light on the subject. It was soon found that this relation is of an inverse exponential nature. Thus when the screen voltage of the '35 is increased from a low value, the tube rapidly approaches an oscillating condition. The nearer the tube approaches the spill-over point, however, the less effect the increasing of screen voltage has upon its tendency to oscillate. Consequently we have a regeneration control that permits of readily obtaining and maintaining a higher degree of regeneration with

the attendant smooth sliding into oscillation so much sought after in ham receivers of the past and obtained only to a fair degree by the careful selection of tubes and the juggling of grid leak and condenser values.

This same characteristic of the '35 that permits of this higher order of regeneration also results in a more stable condition with regard to the holding of the regeneration adjustment when once set. There seems to be entirely lacking that tendency of regenerative detector tubes of ordinary kinds to suddenly "pop" into oscillation on the slightest provocation.

THE AUDIO SYSTEM

The detector output is impedance coupled to the single audio stage by means of a plate choke coil of extremely high inductance value. It was found that the use of an inductance of much higher order than possible with practicable transformer coupling resulted in much higher coupling efficiency and complete elimination of any tendency towards howling, roughness or "backlash" in the regeneration control. These difficulties were encountered to a very objectionable degree when straight resistance coupling was employed.

The grid leak of the impedance coupling arrangement is the attenuation control potentiometer. Such a control was found essential due to the high sensitivity of the receiver and consequent "too loud for comfort" signals when using a head set. Such an audio coupling system results in an extremely flat characteristic over a wide frequency band, making the receiver ideally suited for phone reception.

Originally, serious consideration was given to the inclusion in the circuit of a tuned filter arrangement to follow this coupling device, so as to give a highly peaked audio characteristic for c.w. reception; but as a result of observing some investigations being conducted by Ross Hull, Jim Lamb, and George Grammer at A.R.R.L. headquarters, undoubtedly to be discussed in *QST* in the near future, the peaked audio idea was abandoned, at least for the present.

CALIBRATED ATTENUATION CONTROL

With a potentiometer in the grid circuit as the volume control, it has already been shown how it may perform the double duty of volume control and audibility meter.[4] Fig. 11 shows how the taper of the resistor is determined so that the angle of rotation is directly proportional to the "R" rating of signal intensity. In this case, the total resistance used is 500,000 ohms.

When the contact arm is at the high end, there is zero attenuation and the level of a signal just audible at such an adjustment would be "R1." Likewise, when the control arm is at the other extreme, only a signal of enormous intensity will "get through" and thus the rating of "R9." Physically, the attenuation control is mounted under the chassis; so, like all the other audio components, it is completely shielded from the r.f. circuits and consequently not likely to cause any back coupling which would result in fringe howl. Furthermore, the control wheel is so mounted that it may be operated simultaneously with the main tuning dial, leaving the other hand free for the regeneration control. After operating the receiver a short time, one finds that he unconsciously shifts the attenuation control up and down as he moves from station to station so as to maintain the same signal intensity to the ear, thus making available at a glance a sufficiently accurate audibility reading at all times.

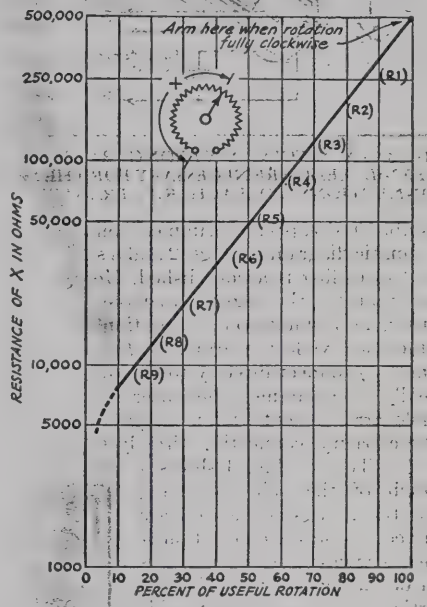


FIG. 5—CALIBRATION CURVE OF THE COMBINED VOLUME CONTROL AND AUDIBILITY INDICATOR

To determine the audibility of signal, the control is rotated to the setting where the signal is just audible, the marking on the disc at this setting indicating the audibility in terms of the "R" system. The calibration is, of course, an approximation.

POWER SOURCES

For complete a.c. operation of the receiver, the type of power pack that has been previously described is recommended.[1] This power unit employs a Type '80 tube as a rectifier, an r.f. filter and a 2-section hum filter. The power transformer, in addition, is equipped with an electrostatic shield between the secondaries and the 110-volt winding, thus not only preventing any r.f. disturbances originating in the power supply from getting into the receiver, but also preventing

[4] McLaughlin and Lamb, "What Is This Thing Called Decibel?" *QST*, August, 1931.

r.f. disturbances originating in the rectifier tube from causing trouble. The elimination of this latter source of r.f. disturbance makes the operation of the receiver entirely free from the so-called "tunable" hum. As shown by the illustration and circuit diagram, the voltage divider resistor for the "B"-supply is located inside the receiver chassis, so as to eliminate any r.f. or common coupling in the power supply leads. By having the power supply a separate unit, any a.c. hum due to coupling between the power transformer and the detector plate coupling impedance is completely eliminated, thus reducing hum in the output of the receiver to an extremely low level.

A unique feature of the battery model is its design to use either battery or a.c. type tubes. When used purely as a battery operated receiver, then the new 6-volt 5-prong heater Type '36 and '37 tubes are recommended so as to permit operation from the standard 6-volt storage battery or "A" eliminator. As will be seen from the circuit diagram, a separate "B-minus" lead is brought out in the battery model. Thus the standard a.c. tubes, also being of the 5-prong UY-base variety, may be plugged in at any time in place of the heater-type battery tubes and the receiver adapted to a.c. operation.

As mentioned previously, an arrangement finding particular favor with many experienced amateur operators at this time is the use of a.c. on only the heaters of the a.c. tubes, so as to take advantage of economical operating costs and the superior characteristics of the '35 as a regenerative detector, "B" batteries being used for plate supply in preference to the so-called "B-eliminator." The operating advantage of such a combination shows up mainly on weak c.w. signals where a higher order of detector stability is obtained, due probably to the elimination of plate supply variations caused by line voltage fluctuations. It would also seem that there is a slight increase in freedom from detuning effects of the regeneration control when using batteries in place of "r.a.c." power supply. The extent of this improvement, of course, depends upon the type of power pack involved and is much more noticeable when using the conventional type "B-eliminator" than when using a special type of power unit designed strictly for high frequency receiver operation.

When using the battery model of the receiver with the combination a.c.-d.c. power supply, a common center-tap resistor should be connected across the heaters *inside the base of the chassis*. It has been found that erratic operation will result on some frequencies if this center tap resistor is placed across the heater terminals of one of the sockets, particularly the detector. If the receiver is to be used alternatively with a.c. and d.c. type tubes, provision should be made for removing this resistor from the circuit when operating with a filament battery so as not to impose a parasitic load on the batteries.

For complete battery operation, the 6-volt heater tubes were selected not only because of the convenient 5-prong base making them interchangeable with the a.c. tubes and because of the general availability of 6-volt storage batteries, but also because of their freedom from the microphonic howls that are causing so much grief where the 2-volt type d.c. tubes are being used. At this writing, a variable-mu tube with a low-current d.c. heater is not available so that it is necessary to use the Type '36 as the screen-grid detector, for the present at least. As soon as the value of the variable-mu tube as a regenerative high-frequency detector is more generally appreciated, however, battery operated models will no doubt become available.

Since the receiver measures but 9¾" x 7", it should prove well suited to portable, aircraft, and other services where space is an important factor. Replacement of the Type '37 audio output tube by one of the Type '38 pentodes of the same series (in the battery model) provides a genuinely compact outfit for speaker operation. In fact, such a change in the audio system results in a rather good short wave b.c. receiver.

Standard National "R-39" R. F. Transformer Coils May Be Used in the "SW3"

"Brown"	No. 10 Range	9.	to	15 meters
"Black"	No. 11 Range	14.5	to	25 meters
"Red"	No. 12 Range	23.	to	41 meters
"White"	No. 13 Range	40.	to	70 meters
"Green"	No. 14 Range	65.	to	115 meters
"Blue"	No. 15 Range	115.	to	200 meters
"Orange"	No. 16 Range	200.	to	360 meters
"Yellow"	No. 17 Range	350.	to	550 meters
"Purple"	No. 18 Range	500.	to	850 meters

One of a series of pamphlets describing outstanding developments in the field of transmitting, high frequency and broadcast receivers, frequency measuring apparatus and other equipment of interest to the Radio and Communication Engineer.

In this instance, we are indebted to *Q S T Magazine* for permission to describe Mr. Millen's new receiver.

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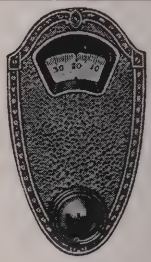

Velvet Vernier Dial
Type E and F

Velvet Vernier Dial
Type G and H

Lever Type Indicator
Type S and J

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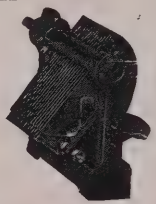
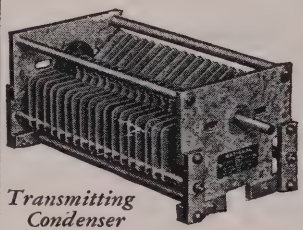
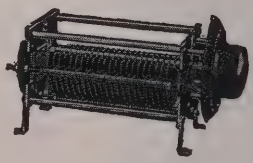
Type N



Girder Frame Condenser
Type EC and ET



Transmitting Condenser
Type T M U



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Here's a closer look at one of the most sought after receivers today. Bill Orr takes us down Memory Lane and back again as we refurbish and use the famous SW-3 receiver.

The National SW-3 Receiver: Revisited

BY WILLIAM I. ORR*, W6SAI

In the July, 1971 issue of *CQ* magazine I wrote a short article about the National SW-3 regenerative receiver[1]. Undoubtedly the story struck a responsive chord as I was inundated with mail from SW-3 owners and amateurs hunting for an SW-3 for their collection (fig. 1). The interest was heart-warming and it is encouraging to see so many amateurs taking an active interest in their heritage and showing a curiosity about some of the marvelous equipment that was manufactured for amateurs during the "Golden Years" of amateur radio.

A side effect of the story of the SW-3 was that the market value of a good SW-3 receiver with coils and power supply shot from a range of approximately thirty-five dollars to well over one hundred dollars in a period

*48 Campbell Lane, Menlo Park, CA 94025

[1]Orr, "The Year is 1931. National Radio Introduces the SW-3 All-Wave Receiver", *CQ*, July, 1971, pp. 34-38.

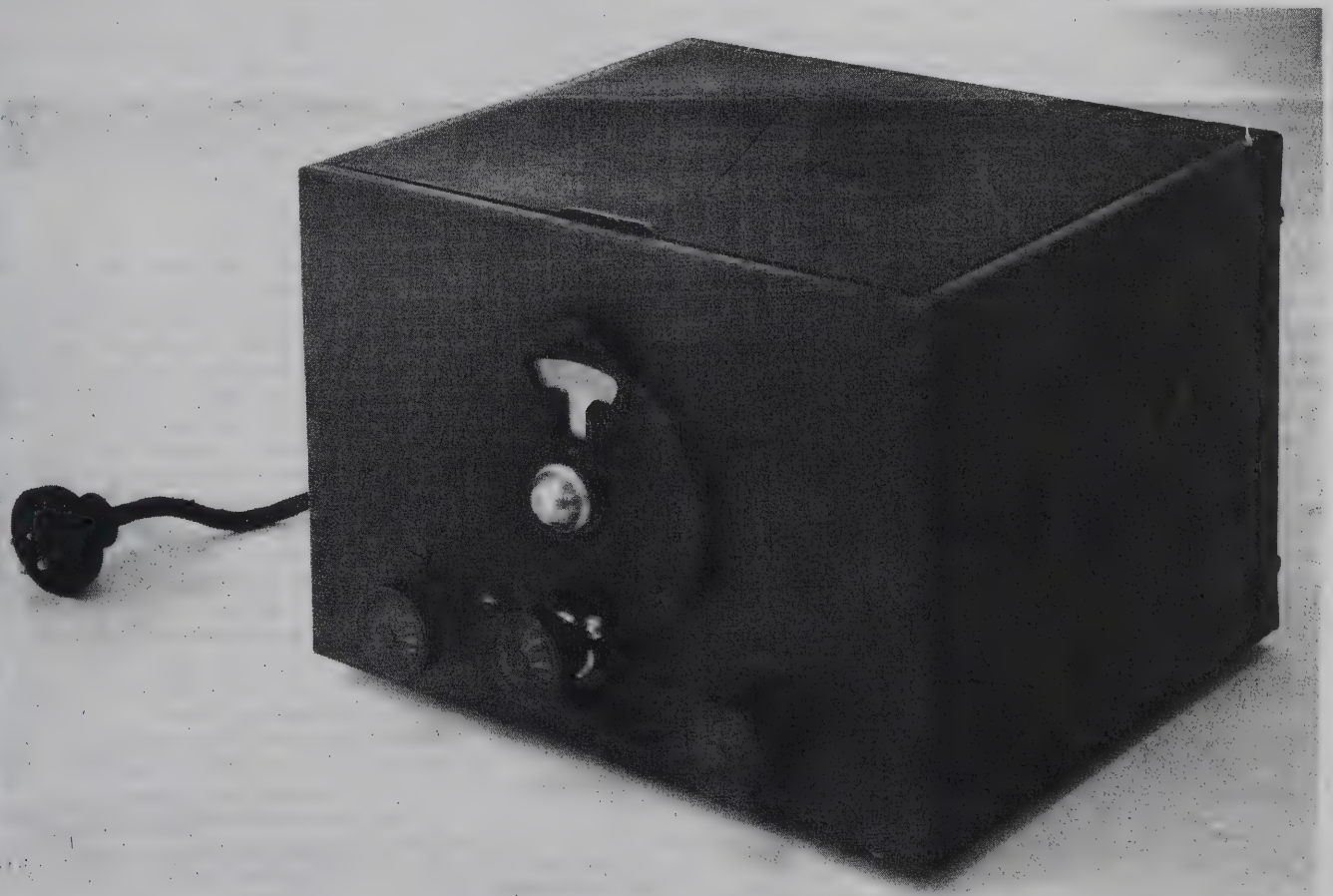

Fig. 1—The popular SW-3 receiver by National Co. This three tube, pre-war beauty is today's hot collector's item. Using plug-in coils, the SW-3 covered all frequencies between 30 MHz and 90 kHz. Panel controls (left to right) are: R-f trim, tuning and regeneration. Below the main tuning dial is the horizontally mounted r-f gain control, calibrated in signal strength units. Receiver required external power supply.

SW-3 Coil Chart
General Coverage

Range (kHz)	Universal Model 3	Model 2	Model 1
90-160	42	72	22
150-220	41	71	21
190-280	40	70	20
250-390	39	69	19
320-650	38	68	18 (purple)
500-900	37	67	17 (yellow)
690-1500	36	66	16 (orange)
1500-2700	35	65	15 (blue)
2500-4500	34	64	14 (green)
4200-8000	33	63	13 (white)
7000-12000	32	62	12 (red)
12000-21000	31	61	11 (black)
19000-35000	30	60	10 (brown)

Fig. 2—Coil data for the SW-3 receivers.

of weeks, and the price is still going up!

Ah, well, they don't make 'em anymore and that's the way the Free Enterprise system works, I guess. In any event, in response to many inquiries, here's some additional information about the SW-3 and its many variations.

SW-3 Variations

As explained in my first article, there are three basic models of the SW-3, with three different versions of Model I. In a few words, this is the story:

SW-3 Model I:

Version 1. Uses 35, 35, 27 tubes and color coded coils. Later coils for this receiver were identified as the "10-20" series.

SW-3 Coil Chart
Bandspread

Band	Universal Model 3	Model 2	Model 1
160	30A	60A	10A (brown)
80	34A	64A	14A (green)
40	33A	63A	13A (white)
20	31A	61A	11A (black)
10	30A	60A	10A (brown)

Fig. 3—Bandspread coil data for the SW-3 receivers.

Version 2. As above, but with 36, 36, 37 tubes and B-plus switch for mobile operation. Used "10-20" series coils.

Version 3. Used 30, 30, 32 tubes (1.4 volts d.c.). Used "10-20" series coils.

SW-3 Model II:

Used 58, 58, 56 (2.5 volt) or 6C6, 6C6, 76 (6.3 volt) tubes interchangeably. Used "60-70" series coils.

SW-3 Model III: ("Universal Model")

Used 6J7, 6J7, 6C5 (6.3 volt) or 1N5, 1N5, 1A5 (1.4 volt) tubes interchangeably. Used "30-40" series coils.

Within these broad classifications there seem to exist many receivers which exhibit small differences. There's a "Marine" model that has toggle switches on the panel for filament control and standby. And I've seen SW-3s that have side handles, apparently put on at the factory. And, of course, many owners of SW-3s in the past have modified or otherwise "butchered" their receivers. Many SW-3s were made into preselectors and some even served as the front-end for home-made superhet receivers. So it is wise to examine the SW-3 before you purchase it or you may be in for an unpleasant surprise.

Receiver Coils

A major problem facing today's owner of an SW-3 is a dearth of plug-in coils. An SW-3 without coils is like a ship without sails. And it is difficult to wind your own coils as the SW-3 coil forms and sockets have an odd-ball pin spacing that matches nothing else!

As the years have passed, coils have been lost or rewound for other purposes and it is a rare receiver that has a full set of coils (fig. 2). In fact, many SW-3s never had a full set of coils, for what 1930 amateur had the pocket money to buy coils at $3.00 a set?

Classified ads and flea markets can often turn up a few coils, but Murphy's Law is still valid and the coils you find may not be the proper ones for your type of receiver, as outlined in the chart. What to do then?

Modifying the SW-3 Coils

It is possible to modify available coils to fit your receiver in many cases. The main differences between the various coil sets are the inductance of the primary and feedback (tickler) windings. The older, Model I receivers used low-transconductance tubes which required a detector coil having a high degree of feedback and a large number of turns in the tickler coil to make oscillation possible for code reception. Hence, the color coded (or so-called 10-20) series coils have more feedback turns than the other coil sets. The feedback winding, by the way, is the winding wound in a slot at the bottom end of the coil. The "60-70" series coils have less turns on the feedback winding, and the "30-40" series of coils have slightly less turns than the "60-70" series coils.

There's a small difference in the plate (primary) winding, too, but that is too much bother to adjust. Besides, I can notice no difference between *any* of the coil sets when the feedback winding is properly adjusted.

It is easy to check a set of coils in your receiver. If the feedback winding is correct, the regenerative detector will go into oscillation when the regenerative potentiometer is set at, or near, mid-position when the r.f. resonator control has been peaked for maximum background noise.

Of course, the point of regeneration also depends upon the plate voltage applied to the receiver, and there's a lot of leeway in regeneration adjustment by merely changing the plate voltage from 90 to 150, or perhaps down to 120 volts.

In any event, the tickler coils can be easily rewound,

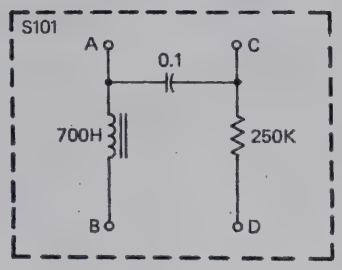

Fig. 6—Interior connections of the "interstage coupler", S-101.

adding or subtracting a turn at a time to provide the proper control settings. A word of warning, however: if you don't want to ruin the resale value of your SW-3, rewind the coils with the same type of wire that was originally on the coil. *(Editor's note: Ho, ho. Try and find green silk covered wire these days!)*

The Bandspread Coils

In addition to the general coverage coils summarized in fig. 2, there exist bandspread coils for the various amateur bands fig. 3. The same remarks concerning the tickler coil may be applied to the bandspread coils Remember, no matter which coils you modify, *make the modification to both coils,* as they are intended to be interchangeable in the detector and r.f. stages of the receiver.

A schematic of the bandspread arrangement is shown in the drawing. You can adjust the exact tuning range of the receiver by means of the variable mica capacitor on the detector coil. And please note that the bandspread coils are unique in that you cannot switch detector and r-f coils back and forth. The detector coil is the one with the mica padding capacitor atop it.

The Long Wave Coils

Fig. 1 shows that coils exist that permit operation of the SW-3 as low as 90 kc (pardon, 90 kHz, that is). These coils are rare birds indeed, and much prized by collectors —especially the coils that cover the 600 meter maritime range. Old timers like to sit and copy ship traffic, for some unknown reason, it seems. Anyhow, the "long wave" coils are a little more cranky, and some of them won't work at all in Model I receivers. The reason? See Figures 4 and 5. In order to sustain oscillation at the very low frequencies, an additional r.f. choke must be placed in the plate circuit of the detector tube. If this choke (L_8) is missing (as it is in early production sets), the detector refuses to oscillate much below 500 kHz. Later production receivers incorporated two r.f. chokes in series and effectively solved this problem.

Even so, after adding the r.f. choke and fiddling with the tickler winding of the detector coil, on occasion I have been completely frustrated trying to make a particular SW-3 perform properly with a set of low frequency coils not matched to the receiver. And the coils are wound in such fashion that modification of the other windings is very difficult. So beware! *Some* low frequency coils may not work in *some* receivers!

Take the SW-3 Apart?

Why not? Some of them are incredibly dirty and should be thoroughly cleaned before operation is accomplished. Outside, the black crackle finish can be cleaned by scrubbing is vigorously with a rough towel dunked in a warm solution of tri-sodium phosphate (TSP at your friendly hardware store). And you can tell if a previous owner was a cigarette or cigar smoker. You'll get a sticky, yellow *guck* off the receiver chassis that smells like a dead ashtray after a New Year's party.

Once the outside is reasonably clean, you are ready to take the receiver apart. These are the steps:

1- Remove the bottom plate and the four sheet metal screws on the sides of the receiver. Remove the lid and back plate.

2- Remove the two front sheet metal screws. Remove the two knobs at the sides of the front panel. Remove the lock nuts on the regeneration potentiometer and the antenna resonating capacitor. Loosen the set screw for the tuning shaft under the center cap on the dial.

3- Inside the receiver, unsolder the two ground lugs on each internal shield. The lugs lie on each side of the tuning capacitor.

4- Unscrew the three tiny nuts that hold the dial in place.

You can now slide the chassis out of the cabinet, first making sure the dial light is removed from the panel clip. The chassis and interior of the cabinet can now be cleaned with the TSP solution and the rough towel.

Want to remove the dail to clean the rotary disc? You can do it now. The dial comes apart if you take off the knob. You'll see that the dial assembly is held together by means of a locking pin on the dial drive shaft. If you remove that.....easy! Watch out! There is a pin-spring-bushing assembly at this point. Study it before you pull the pin. Everything is under tension.

When I took my dial apart the first time I pulled the pin out of the shaft with a long-nose pliers. There was a loud *twang.* The spring and bushing flew out. A nearby window was conveniently open. I watched with open-eyed horror as spring and bushing flew out the window into the yard. It took a good 15 minutes of painstaking search to find the spring and bushing. In fact an ant was already hauling the bushing off to feed it to its offspring!

Keep track of all loose hardware! Once everything is in ship-shape you can reverse the process and reassemble the receiver. Oh, yes! Notice that the condenser drive shaft of the dial has a phenolic insert and the dial is electrically insulated from the tuning condenser shaft. This is done to reduce dial noise, which can show up when two ground returns exist in the tuning system. *Don't* loose this bushing.

While you are at it, you might as well check out the interstage coupler in the tin can at the back of the receiver (fig. 6.) Use an ohmmeter for this. In fact, it is a good idea to measure this unit *before* you buy an SW-3. If the primary choke (L_9) is open, you have a problem, as they ain't making replacement parts anymore!

Receiver Overload

Back in the Golden Years of amateur radio most amateurs ran inputs of 10 to 100 watts, with the majority of signals running at the 50 watt level. The "California Kilowatt" was not unknown, to be sure, but it was a very subdued beast.

Today's electronic environment does not suit the SW-3 well. A regenerative detector is very susceptible to overload and the overload capability and strong signal rejection of the SW-3 are poor compared to today's modern receiver. The worst thing you can do to your SW-3 is to hook it on to your beam antenna. The receiver will choke on the strong signals of 1978.

A good antenna for the SW-3 consists simply of about 20 to 30 feet of wire, high and in the clear. Use a good

(Continued on page 75)

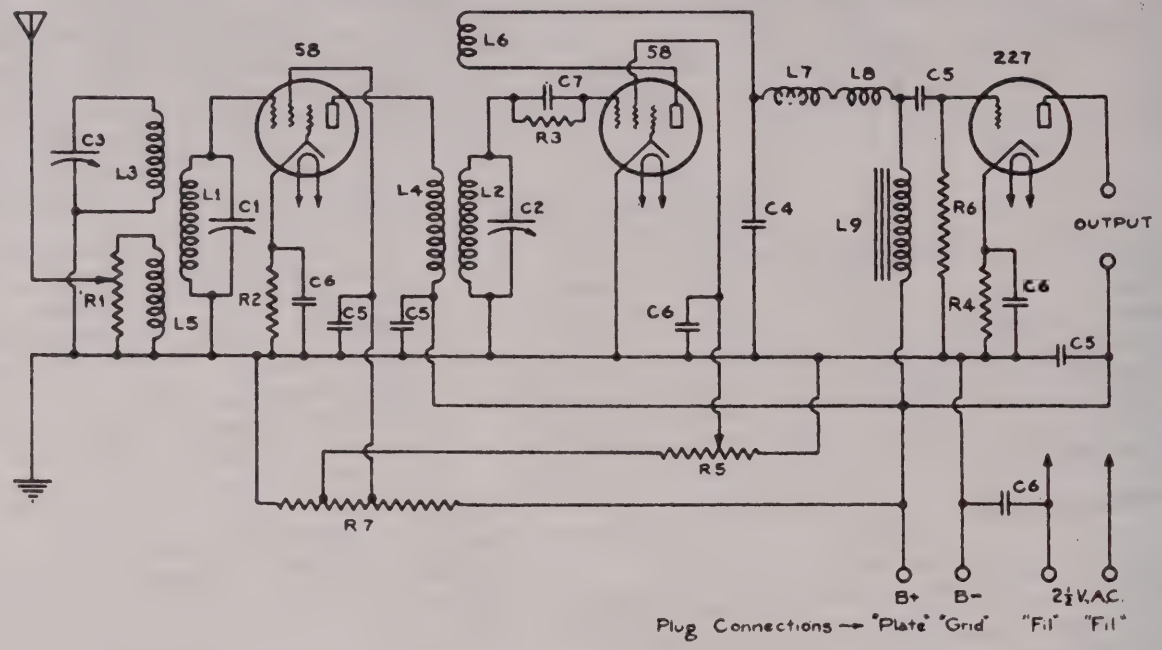

Fig. 4—The a-c model of the SW-3 using 6.3 volt or 2.5 volt glass tubes. This early version of the Model II receiver has the r-f gain control wired as a potentiometer in the antenna circuit. Later models shifted the control to the cathode circuit of the r-f tube so that the operating bias could be increased, dropping the stage gain.

CIRCUIT DIAGRAM OF THE ACSW-3

This receiver employs only a-c tubes, as indicated, and should be selected for complete a-c operation, or for partial a-c operation (using plate batteries) where a 2.5 a-c heater potential will always be available. The circuit constants are as follows —

L_1, L_2, L_3, L_4, L_5 and L_6 — R.F. Transformers.
L_7 — No. 100 Ultra High Frequency R.F. Choke.
L_8 — No. 92 Low Radio Frequency Choke.
L_9 — 700 Henry Choke — Part of S-101 Audio Coupler.
C_1 and C_2 — Ganged S.F.L. 270° Tuning Condensers with isolated rotors. 90-μμf per section.
C_3 — Midget Type Trimmer Condenser — 50-μμf.
C_4 — 250-μμf mica by-pass condenser.
C_5 — .01-μf non-inductive mica fixed condensers.
C_6 — .5-μf non-inductive paper by-pass condenser.
C_7 — 100-μμf small mica grid condenser. Incorporated in Detector R.F. transformer.
R_1 — 3000 ohm potentiometer — special taper — used as gain control.
R_2 — 300 ohm cathode resistor, 2 watt type.
R_3 — 5 megohm detector grid leak.
R_4 — 2000 ohm cathode resistor, 2 watt type.
R_5 — 50,000 ohm potentiometer for regeneration control.
R_6 — 250,000 ohm audio grid resistor — part of S-101 Coupler.
R_7 — Voltage Divider-total resistance 12,000 ohms.

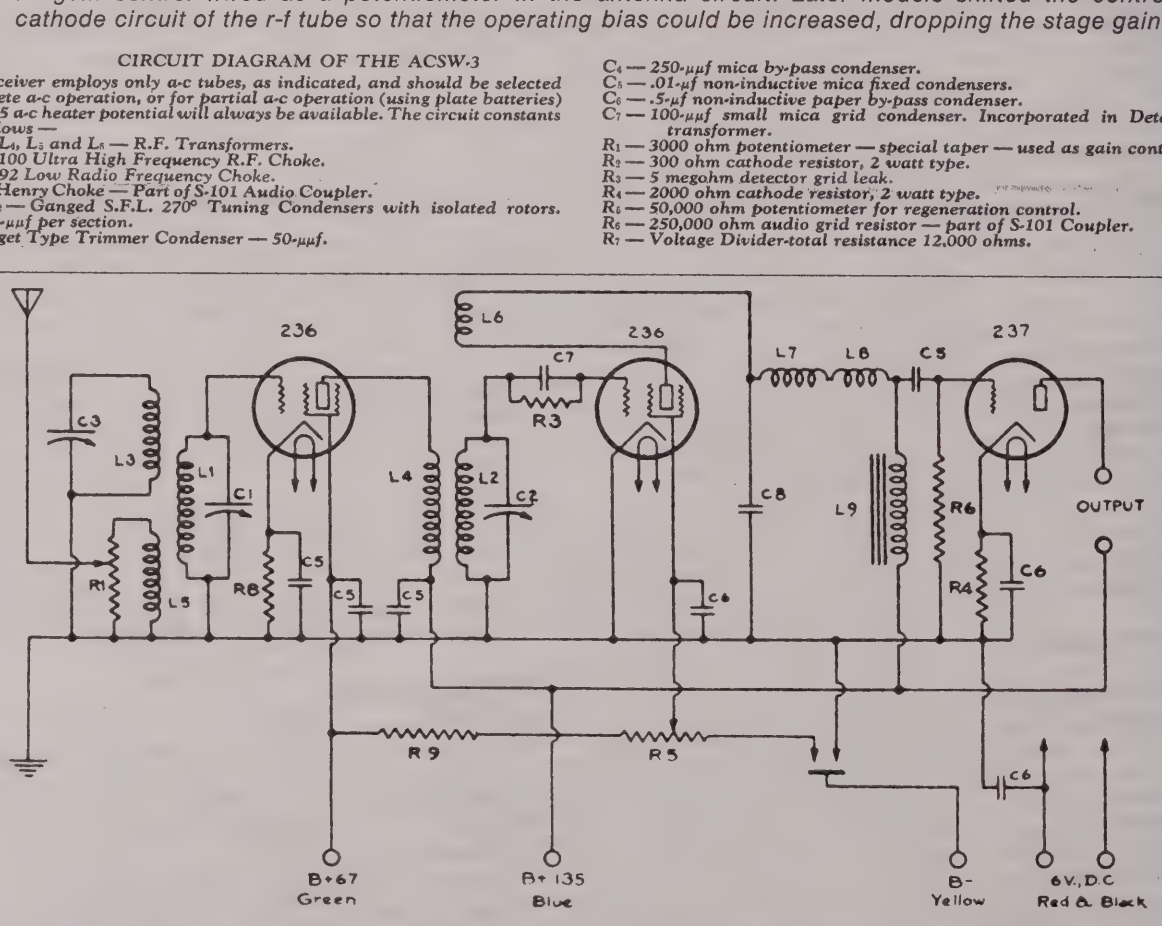

Fig. 5—Circuit of the Model I, version 2 receiver designed for mobile operation or battery operation. Same general circuit as shown in Figure 4 except for addition of a B-plus power switch and the omission of the bleeder resistor for the r-f stage screen supply. A 5-prong power plug is used with this receiver.

CIRCUIT DIAGRAM OF THE DCSW-3

This is the combination circuit which should always be selected when battery operation may be required. It can, however, readily be converted to a-c operation using the standard 235 and 227 tubes. The circuit constants are identical with those indicated in Figure 4, with the following exceptions —

R_8 — 350 ohm resistor.
R_9 — 20,000 ohm 2-watt type resistor.
SW — Regeneration control and cathode circuit switch.

Speech Processing *(from page 72)*

of infinite clipping. In such a situation the output of the clipper is just a square wave signal. Again low frequency roll off was used before the clipper. This time to reduce the power of harmonics from the low frequency first formant signal due to clipping from interfering with the second formant signals. The optimum high pass filter was found to have a 1.1 kHz cut off frequency with a 12 db/octave roll off. The result is shown in curve **A**. At positive S/N ratios it beats curve **C** somewhat, but at negative ones it rapidly falls off. This is probably due to the fact that even with the filter, harmonics of the lower frequencies are still present, and therefore still interfere with the second formant.

Finally, a fast time constant compressor was tried again with a high pass filter before the compressor. The optimum high pass filter was found to be a two kHz cut off frequency with 6 db/octave roll off. The results are shown in curve **D**. It was the best of them all except for very low S/N ratios. This is due to the fact that compression creates much less harmonic distortion than does clipping.

Finally, that customary question "How does it sound?" I tried a syllabic compressor with the 2 kHz filter and recorded it. You could tell that the speech was not normal since it lacked lows, but it was by no means garbled. It had a very crisp sound to it, but it did not make me sound like the medieval Italian *Castrati.* During an on the air test, one station asked me to turn it off because he didn't like its sound. On the next go-round he asked me to turn it back on again since he was missing an occasional word. Then I knew it must be working! Other comments were that it was "easy copy" through the QRN on 75 and QRM on 20.

In summary, doing processing at the r.f. level is better since harmonic distortion is easy to filter out, compression is better than clipping since less harmonics are generated to begin with, and low frequency roll off reduces these harmonics even further and gives a crisp easy to *copy* sound. Most important, intelligibility is the criterion not fidelity; how does it work is more important than how does it sound. ■

SW-3 Revisited *(from page 40)*

ground connection on the receiver. Finally, place a mica compression trimmer in series with the antenna right at the receiver terminal. Use as little capacitance as you can and still get good, strong signals. You will be surprised at how little capacitance is needed. The SW-3, in fact, will perform wonders with as little as 10 feet of antenna wire on the higher bands. For 80 and 160 meter reception, a minimum of 20 feet of wire is suggested.

The sensitivity of the SW-3 is amazing. Properly peaked up and with optimum antenna coupling, you'll hear everything your station receiver can hear, right down to the background noise. You'll be limited by antenna pickup, since you are probably used to having a beam hooked to your station receiver. But the SW-3 has "ears" like an Iroquois Indian scouting party, so don't be surprised when you hear that exotic DX-pedition station rolling in on the little receiver.

Receiver Power Supply

The SW-3 works very well at a plate potential of 90 to 150 volts. At the lower plate voltage, you may find that the receiver won't break into regeneration on the lower frequency coils. You can use a National power supply (if you can find one). I use a small, surplus 140 volt regulated supply that does the job nicely.

Examine your SW-3 to see if one side of the filament leg is grounded in the receiver. Most of them are wired that way. A few receivers, however, have the filament circuit

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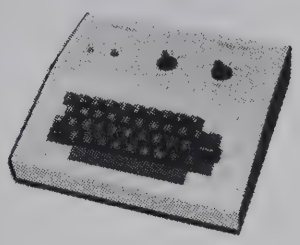

New Model 150 RTTY Keyboard

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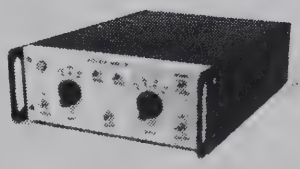

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ungrounded. One leg of the filament should then be grounded in the power supply, or a hum may exist on strong signals. Other receivers have a built-in filament center-tap resistor and these receivers should use a filament supply that is not grounded in the power supply.

Good Luck With Your SW-3

This little set is a popular collector's item and its value will increase as the years go by. Best of all, you can hook it up and listen to it! You must use high impedance earphones (2,000 ohms to 5,000 ohms). Low impedance phones just won't work unless you place a matching transformer between the receiver and earphones. A pee-wee transformed to match a pentode output tube to a speaker voice coil will work OK.

Get your receiver working and start listening. You'll be surprised at the DX you can hear! ■

Computers *(from page 30)*

Interested in conversation with your computer? While not truly a reality, hobby grade equipment is available allowing the hobbiest to experiment with speech synthesis and recognition.

Word processing is available on some systems with the appropriate hardware and software. This might be used for putting the professional touch on letters and documentation.

Perhaps some software to help children with their math homework or a recipe file for the wife would be useful.

Amateur radio users can use their system to send and receive code and to process, transmit, and display slow scan television images, plus do their logging.

Where Are They Available?

Computer equipment is available through mail order houses or local computer stores. The potential buyer should be careful to deal with a reputable firm. Although the hobby computer industry is relatively young many businesses have found themselves forced to close their doors. Continued price declines and increased product offerings will almost certainly contribute to the demise of many more in the next year. Those who feel a deficiency in computer hardware or software should seek the assistance of other hobbiests or professionals in their area.

Is It Really Worth It?

Caution should certainly be exercised while considering entry into any avocation. It is important not to become overwhelmed by the potential problems. If the possible rewards or gains of hobby and personal computing are assessed realistically by an individual, the answer to the question "Is it really worth it?" can be a resounding YES! Even if a decision is made not to enter into hobby computing at the present time, keep it in the back of your mind—the situation might change tomorrow.

Coming Up In Future Issues

Future issues of *CO* will contain articles on Computer Hardware and Software—"What are They" and "How Do They Work" along with reviews of products of particular interest.

Next: COMPUTER? What is it?

TVI and CB *(from page 28)*

issued Docket No. 21116, which proposes to amend the Commission's Rules to prohibit the marketing of external radio frequency amplifiers capable of operation on any frequency from 24 to 35 MHz.

Finally, as a result of CB-RFI problems which are related to the use of Amateur transmitters and transceivers by communicators on the 27 MHz Citizens Band, and because such Amateur equipment does not now fall under the Commission's regulations on type acceptance and marketing, the Commission has issued Docket No. 21117. This Docket proposes to amend the Commission's Rules to require type acceptance of equipment marketed for use by operators in the Amateur Service. And while the Commission would not require the spurious and harmonic attenuation levels of type-accepted Amateur transmitters to be as great as those imposed on CB transmitters, the fact that type acceptance might be required for Amateur equipment represents a departure from the traditionally-held view that such regulations impede the innovative process within the Amateur Service.

To say the least, Amateurs have much at stake in the deliberations which address CB-RFI. As such, we can ill afford to ignore the effect such proceedings might have on the Amateur Service.

The Bottom Line

The FCC study on television reception difficulties associated with CB radio transmitters indicates that TVI (and, indeed, RFI, in general) is a very serious problem. Further, given the fact that millions of households are now affected by RFI, and that increased regulation of the CB and Amateur Services may evolve as a result of such interference, it behooves all parties concerned—the radio operator, the manufacturers of CB and Amateur equipment, the manufacturers of electronic home-entertainment equipment, and the Commission—to work together in resolving RFI problems. Such a coordinated approach appears to be the only way in which to resolve for all time one of the most complex problems facing the CB and Amateur Services.

Copies of the report, entitled "The Extent and Nature of Television Reception Difficulties Associated with CB Radio Transmissions," are available for inspection at the FCC's Public Information Office, Room 202, 1919 M Street, N.W., Washington, D.C. The report may be purchased from the Downtown Copy Center, 1730 K Street, N.W., Washington, D.C. 20006. Telephone (202) 452-1422. ■

The Giant LCD Clock *(from page 23)*

indoors on a very cold day, the display may not read correctly—one or more "extra" segments may light up. This happens because of condensation between the IC or LCD sockets' closely spaced "lands" on the PC board, or moisture between the contact areas on the LCD itself. Normal drying in warm room air should alleviate the problem. Plug in the clock and let it operate for 15 to 30 minutes to restore normal operation.

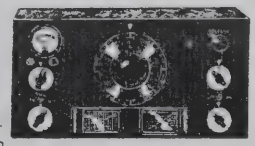
Back-Lighting The Display

If you add a small fluorescent or incandescent light source *behind* the LCD the visibility of the large time numerals will improve. The light should be mounted out of direct line of sight, so as to cast light on the display, without the light-source itself being visible through the LCD panel. An angle-mounted plane mirror is a good choice for reflecting light onto the display. Choose one about the same width as the LCD panel and about half its height. Alternatively, aluminum foil can be used as a flexible, easily worked reflector. ■

Warning

The digital clock is powered *directly* from the a.c. line. Accordingly, it should be housed in an insulated case or enclosure, to protect children and non-technical admirers from accidently touching "live" connections and receiving from accidentally touching "live" connections and receiving a shock.

THE COMMUNICATIONS RECEIVER



EDITED BY **WILLIAM FIZETTE, W2DGB**, RR 1, BOX 55, HENRYVILLE, PA 18332
PLEASE INCLUDE SASE FOR REPLY.

The Remarkable National SW-3

The descriptive term "remarkable" is often used carelessly. But when it is applied to a little stripped-down regenerative receiver, born in the cash-scarce years of the early 1930s, which had a 14-year production run of over ten thousand units, which was used worldwide in all sorts of applications and environments, and which is now a sought-after collector's item, the word is well chosen.

A number of communication receivers from the "golden age" have accumulated a substantial body of literature. The SW-3 is certainly one of them, and my file is replete with numerous articles from *CQ, QST, Electric Radio, The OTB*, and other publications. Noteworthy among these is the landmark *QST* article by Jim Millen, (then W1AXL and later W1HRX) (1) the two papers in *CQ* by Bill Orr, W6SAI (2), (3), and a superb article in *Electric Radio* by my fellow National enthusiast Jim Hanlon, W8KGI (4).

There are other delightful and informative articles by Faulstick (5), in *Riders Manuals* (6), in various National Company instruction manuals, and by Ruggere and Troe (7). Additional information on the coils, as well as a summary of the various power supplies, can be found in *The OTB* (8), (9). There are, of course, many other sources, but the above will give the reader a good overview.

Physically, the SW-3 in its various models is an ugly little black steel box with a hinged lid and a longest dimension of less than 10". It has four front panel controls. There are three tubes, with two plug-in coils for each frequency range. The power source is external: batteries or certain of the famed National "doghouse" AC supplies.

Background

The National Company began as a manufacturer of radio parts, and in time produced finished products using those parts. Thus, the SW-3 with its plethora of interesting features did not just suddenly emerge from the National laboratory. There was a considerable prior development history that included the distinctive tuning capacitors, the unique dial and knobs, the 5880 "doghouse" power supply (with a circuit that eliminated "tunable hum"), and especially the distinctively-based National R-39 low-loss plug-in coils. (NOTE: The question is frequently posed as to why National didn't use the standard six-pin tube base; the answer is simply that their version was designed first.)

One prior product was the 1930 SW-5 five-tube "Thrill Box." It was a deluxe short-wave radio housed in an ornate metal cabinet and using grooved R-39 plug-in coil forms. The SW-5 sold for $85.00, and the 5880 AB power supply cost an additional $20.00.

Driven by the adverse economic conditions of the deepening Depression, James Millen's National design group stripped the SW-5 circuit of everything not essential for communications use while keeping the fundamentals in place. They removed the power audio amplifier (the user would now need headphones), replaced the tuning capacitor's fancy drum drive with the much cheaper Type C dial, and changed the capacitors to an in-line configuration. The cabinet was now a simple, uncomplicated steel box with a hinged lid.

In short, the Millen group produced a very basic radio for a relatively low price, which the user could supplement with additional coils, an audio amplifier, and so forth as money permitted. Wholesale Radio Service Co. in New York listed the set at $32.34. The price included three sets of amateur-band coils, but not the tubes. This was considerably less than the cost of the SW-5, and much more in line with prevailing economics. The price of the matching #5880 power supply was $20.30, essentially unchanged.

The full-page introductory ad for the SW-3, reproduced here, appeared in the October 1931 issue of *QST*. This, of course, followed directly on the September *QST* article mentioned above, and is an excellent example of the sophistication of National marketing strategy under Millen's guidance. Another example, of course, is the offering of accessory coil sets covering a wide range of frequencies. Who could resist spending a few dollars now and then for coils that opened up new listening possibilities?

The Circuit of the SW-3

The three-tube SW-3 circuit includes an r.f. stage, a regenerative detector, and a single audio amplifier. There were eventually three versions, referred to now as Models I, II, and III. Model I is scarce today. Model II debuted about 1936. It is the one mostly found today, and is the subject of my restoration column elsewhere in this issue. See that column for a copy of the schematic.

The Model III, designated SW-3U, "The Universal," was manufactured in limited quantities in the late 1930s and up through 1945. It was designed to use either 6-volt metal tubes or 1.4-volt battery tubes. There are not many Model IIIs around today.

While the tubes and some of the components and circuitry varied somewhat as different versions of the SW-3 emerged, the basic circuit remained constant, as did the external appearance. One minor exception to the external appearance differentiates the first model from the succeeding versions; the lid of Model I is flat, while the later models has a raised finger lip in the front center. Also, looking down inside the Model I with the lid raised, the two-section tuning capacitor consists of two National type SE-100s ganged with an insulated coupler, and held to the chassis with four screws. Subsequent versions used a dual National 2SE-100 mounted with a special bracket in the rear, and directly to the main dial drive, a National Type C, in front.

The S-101 Audio Coupler, a potted transformer device mounted at the rear of the tuning capacitor, appears to have been introduced with the SW-3. I haven't found it listed in the earlier National catalogs at my disposal. The unit consists of a 700 Hy audio choke, a 0.01 mfd coupling capacitor, and a 250,000 ohm grid resistor. It is easy to check with simple radio bench test gear, and can be rebuilt if necessary. Details are in the restoration column in this issue.

Special Features

William Orr began his *CQ* magazine series on classic radios with an article on the SW-3 (2). Orr was a friend of Jim Millen (formerly the VP in charge of product development for the National Company). He stated that the 1930 SW-3 design, which was years ahead of its time, was marketed to commercial airlines (for which its light weight was ideal) as well as radio amateurs. Pan American Airways, believing that good c.w. equipment was more efficient than the existing radiophone apparatus, used the SW-3s on its overseas clippers—mainly the South American routes.

One of the major features of both the SW-3 and the predecessor SW-5 was dependable sin-

Setting a New Standard
in HF Receiver Design
NATIONAL SW-3
This new Ham receiver follows essentially the same circuit as the new NATIONAL SW-5 THRILL-BOX but being for headset use only, omits the Push-Pull Audio.
FULL A. C. MODEL
Uses Type No. 235 and 227 tubes, and operates on full A.C. with National type 5880 Power-Pack, specially designed for hamlet operation with RF filter, two-section Ham-lite, and electrostatic shield between secondaries and line winding (eliminating "tunable" hum).
UNIVERSAL MODEL
Uses new 6 volt, five-prong heater type No. 235 and 237 tubes for battery operation; or Type No. 235 and 227 tubes can be used with 2.5 volts A.C. on the heaters and batteries for B-supply.
SPECIAL SHIELDING
Special shielding in the SW-3, the result of careful research, is one of the reasons for its remarkable efficiency.
HIGH SIGNAL-TO-NOISE RATIO
The combined results of careful circuit design give exceedingly high signal-to-noise ratio.
COMPACT — ADAPTABLE TO PORTABLE, AIRCRAFT AND BOAT USE
Receiver is extremely compact. 9" x 9¼" x 7". Simple, attractive metal cabinet is standard equipment, and forms integral part of the shielding. It can be equipped with hooks for spring mounting on airplanes and will fit in a very small space.
SINGLE CONTROL
The SW-3 has true single control. Set and forget the antenna trimmer. Special RF Variables have insulated main bearings and constant-impedance pig tails and are insulated with R-39.
BAND-SPREAD COILS STANDARD EQUIPMENT
Standard equipment are Band-Spread Coils for 20, 40, and 80-Meter Amateur Bands.
REAL GAIN IN RF STAGE
The design makes possible a real RF gain because of lower plate impedance of 235 tube.
THE PRICE IS RIGHT
The price of the SW-3 puts it within the reach of every amateur. Write us for full particulars and prices using coupon below.
CALIBRATED ATTENUATION CONTROL
In the SW-3, the attenuation-control is an Audibility Meter. Designed so that angle of rotation is directly proportional to the R-Rating of signal intensity, the signal intensity may be read directly on the control. The control wheel is so mounted as to be operated with the same hand as used for tuning, leaving the other free for sensitivity control.
SMOOTH SENSITIVITY CONTROL
Employing a hitherto unknown and unused characteristic of the 235 Variable-mu tube, the point of maximum sensitivity is approached on an inverse exponential curve. Result: — extremely stable operation at maximum sensitivity, without critical control-setting.
NATIONAL
SW-3
AMATEUR HF RECEIVER
COUPON
National Co. Inc.
61 Sherman Street
Malden, Mass.
Gentlemen:
Please send me full particulars and prices on your new SW-3 Ham Receiver.
Name.....
Address.....
City.....
Say You Saw It in QST — It Identifies You and Helps QST

Original announcement of the SW-3 receiver from the October, 1931 QST.

gle-dial control, with the rf and detector gang-tuned. The success of this system in National receivers was due to careful engineering and manufacturing, using quality parts.

The Tuned Circuits. The tuning capacitors, specially built by National, have two electrically-independent ganged sections. The rotors were isolated from the frame and each other. The coils were of moisture resistant R-39 molded formulation and wound with distinctive wire. They were grooved for the primary and secondary turns and had slot windings for the ticklers.

The bandspread coils had tapped secondaries, with a trimmer capacitor and grid leak located inside the detector coil. When these coils are used, the grid clips are removed from the caps of the r.f. and detector tubes and placed on fiber blanks provided in the cabinet. Grid leads from the coils are clipped on instead. These were very stable coils that functioned well under adverse humidity conditions, and the combination of quality components gave the tank circuits an inherent stability that was remarkable for the day.

Ten coil sets covered the useful range of 9 to 2000 meters, with bandspread coils available for the five major amateur bands then in use. Model I used the 10-20 series; II the 60-70 series; and III used the 30-40 series coils. The only apparent difference is the number of tickler turns in the slot winding.

The bandspread coils have the suffix "A" after the number. Early coils were not numbered, but color coded, with either a dot on the bottom, or a color-filled slot on the top edge. Coils from one series may be usable in another, but obtaining proper regeneration (it should occur about mid-range on the control) could be a problem.

Some signals can still be picked up even without proper regeneration, allowing you to check the frequency range of unmarked coils. If you have access to the coil specifications, you can rewind the tickler of a mismatched coil. Often a single turn, or a fraction of a turn, will make the difference.

As of this writing, coil specifications, as well as forms for winding new SW-3 coils can be obtained from James Fred (5355 S 275 West, Cutler, IN 46920, phone 765-268-2214). These excellent quality forms do not have the primary and secondary winding grooves of the original National parts, though they do have the tickler slot. Wind your coils carefully and they will work fine. You may also find some defunct original National forms that can be rewound. If you take this job on, a good source of quality wire is an electric motor repair shop.

Other Issues. Proper interstage shielding is critical for a sensitive, controllable regenerative receiver. Any interaction between the RF and detector stages must be minimized. Not only does the SW-3 have a standard shield for the r.f. tube, but the RF and detector stages are isolated by distinctive metal shields welded to the cabinet. Details of the development of this and other features are in Millen's landmark *QST* article, which was often included in SW-3 instruction manuals.

The thumbwheel gain control is calibrated in R units (the signal-strength units of the day). I've seen various National SW-3 schematics placing this control across the antenna coil, in the cathode of the RF stage, in the RF grid return, or in the grid of the audio stage. The Model II described in my restoration column in this issue has the control in the audio stage, with the RF tube operating wide open. That approach appears less than satisfactory, and when time permits, some tinkering is indicated. This may in part explain a comment by Paul Bohlander, W3VVS, who has restored twelve SW-3s and found that while they all look alike, "they are all different."

Nowdays there is a romantic aura surrounding the SW-3, which after all was just one product among many offered by just one company in the growing electronics industry of the 1930s. Its popularity has to be traced to a combination of adroit marketing and careful engineering, coupled with over a decade of experience and National's reputation for quality products in this new field. For years the SW-3 was used by hams, government agencies, commercial stations, airlines, ships, expeditions, and anywhere else that a versatile, simple, light-weight dependable receiver could apply.

The radio worked, and it worked well. Its success certainly must have done a lot for National's reputation and cash register.

Additional Comments

I asked Jim Hanlon, who has contributed to this column in the past and written extensively for *Electric Radio* magazine, to review this article. His own article on the SW-3 has been previously cited (4). His paraphrased comments follow.

1. Your date of 1936 for the introduction of the Model II agrees with Orr's article. However, the fellow who sold me my Model II told me it was built in 1933 or 1934. He should have known, since he was a member of the radio club that originally purchased it and later bought it from the club.

2. Regarding a source of coil wire, I would

(continued on page 32)

COMMUNICATIONS RECEIVER, *continued from page 30*

add that Antique Electronic Supply www.tubesandmore.com lists magnet wire in at least 8 gauges. They sell full spools for reasonable prices, $5.50 for a 100-foot spool of #21 or #22, up to $4.95 for a 750-foot spool of #42. They also sell Celanese-covered wire, including Litz wire, by the foot.

3. You might want to tip off your readers about the information regarding winding a 30-meter bandspread coil pair that appeared in my 1993 article. I don't know of any other place that it has appeared.

4. Finally, I would also suggest that you assure your readers that the SW-3 is more than just an interesting antique. Several of them show up in the various AWA contests, usually paired with a 210 Hartley, TNT or TPTG. I've worked the east coast from New Mexico on 80 meters with my pair. The SW-3, while not at all selective, is sufficiently sensitive to hear atmospheric noise with its tuned RF amplifier stage. With a little coaxing and given a not too crowded band, it will do just as good a job as a modern superhet.

REFERENCES

(1) Millen, James, *QST*, September 1931.
(2) Orr, William, *CQ*, July 1971.
(3) Orr, William, *CQ*, February 1978.
(4) Hanlon, James, *Electric Radio*, August 1993.
(5) Faulstick, Roger, *Electric Radio*, Dec. 1993, January and February 1994.
(6) Riders Manual, Volume 14. (NOTE: There is gold mine of information on other National receivers in this reference.)
(7) Ruggere, R., and Troe, James, *ARCA Gazette*, Vol. 19, #4.
(8) Fizette, Wm, *The OTB*, August 1993.
(9) Fizette, Wm, *The OTB*, February 1993.

* (CONT)
RF GAIN POT — HE FOUND
THAT THE LEADS ACROSS
FROM THE RF TUBE PLATE
TO THE DETECTOR COIL
PRIMARY WAS ROUTED
INCORRECTLY —

WHEN CORRECTED, IT
PERFORMED OK

BY BILL FIZETTE, W2DGB

A STRUCTURED APPROACH TO FIXING UP THOSE NICE OLD RADIOS

More on the National SW-3

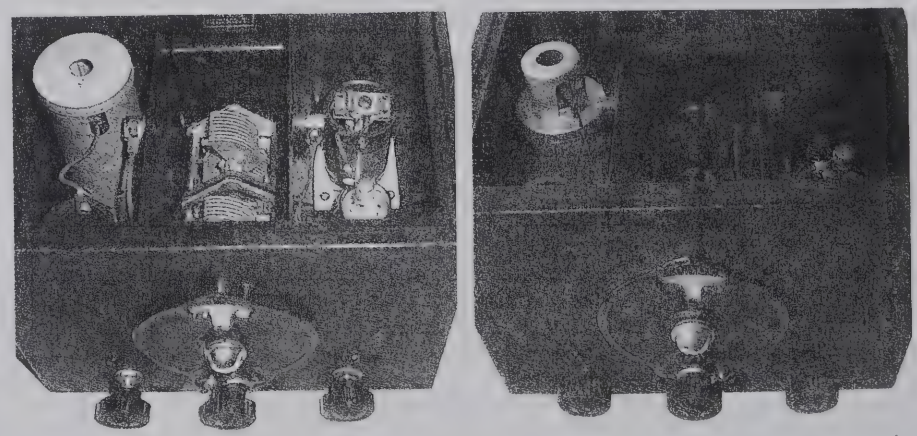
In the aftermath of my two November 2003 columns dealing with the legendary National SW-3 regenerative receiver, several items have come to light.

In the "OOPS" category, I had commented that the National Company began as a manufacturer of radio parts. What I meant was that the National Company entrance into the radio field was as a manufacturer of radio parts. The company was incorporated in 1914 as the National Toy Company, and they made power plant items, household items, and... toys. National began making radio parts in 1922.

Another "OOPS" item involves the S-101 coupler diagram on page 56 and its accompanying text on page 57. The correct capacitor value is 0.01 mFd, not 0.1 mFd as indicated.

For the record, the tube shield shown in the photos on pages 54 and 56 is the National type S with the large cap, which is the one I happened to have in my shop. The correct shield on the original receiver was the type T58 with the smaller turret-style cap.

Paul Bohlander, W3VVS, commented about the National ad that was reprinted on page 29. "The National ad that appeared in the October 1931 issue is very interesting. If you have the *QST* issue, the picture at the upper left is of the very first Model 1 without the tube shield on the RF tube. Look closely and you will see the outline of the 3¼" × 3½" shield that was placed between the coil and the RF tube to prevent stray coupling between the tube plate and the coil. The shield was fastened to the chassis with two self-tapping screws randomly located on the lip at the bottom of the shield. Later versions incorporated a tube shield."



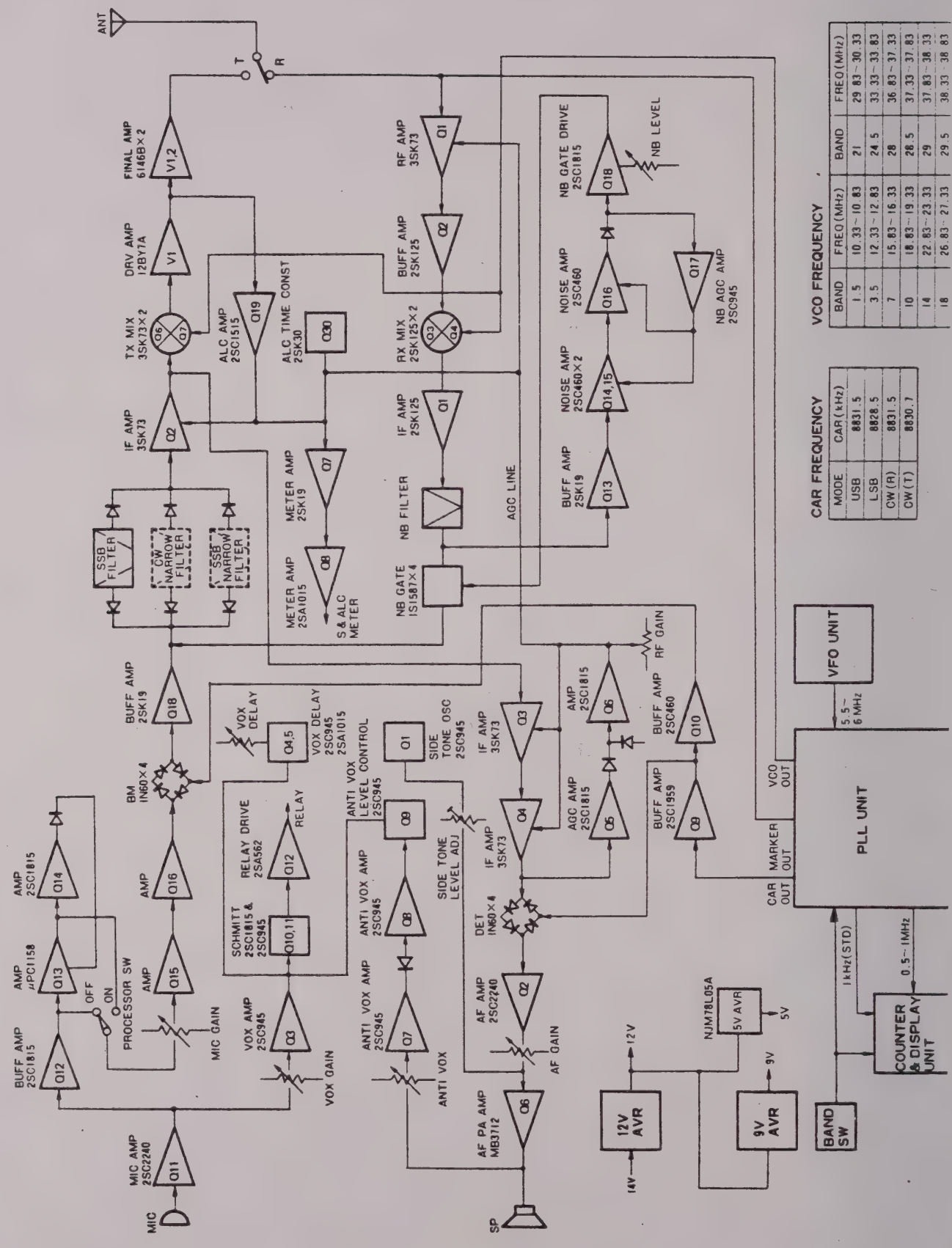
Author's SW-3 (left) has type S tube shield and a set of bandspread coils. Compare with SW-3 at right, which has the correct type T58 shield and one of the general coverage coil sets.

Reader Tom Turner, K8VBL/VP2VEL, wrote: "A number of years ago I bought an SW-3. The type B dial was missing, and the National special coil sockets had been replaced by standard six-pin sockets. Inside the lid a name plate was riveted, "Clough-Brengle Co, Chicago. There was no grease-pencil red "OK" in the corner of the lid, as was generally written by Cal Hadlock when he checked out the completed SW-3s. The dial and the coil sockets were replaced, and new coils were wound on National forms, but the RF stage would break into oscillation at high settings of the

(continued on page 58)

RR 1, BOX55, HENRYVILLE, PA 18332 e-mail w2dgb@enter.net

BLOCK DIAGRAM



CAR FREQUENCY

MODE	CAR (kHz)
USB	8831.5
LSB	8828.5
CW (R)	8831.5
CW (T)	8830.7

VCO FREQUENCY

BAND	FREQ (MHz)	BAND	FREQ (MHz)
1.5	10.33 - 10.83	21	29.83 - 30.33
3.5	12.33 - 12.83	24.5	33.33 - 33.83
7	15.83 - 16.33	28	36.83 - 37.33
10	18.83 - 19.33	28.5	37.33 - 37.83
14	22.83 - 23.33	29	37.83 - 38.33
18	26.83 - 27.33	29.5	38.33 - 38.83

INSTRUCTIONS

FOR
AMATEUR BAND SPREAD COILS

These coils are designed for use in the standard SW-5 Thrill Box, either A.C, or Battery model, and may be simply plugged in the coil sockets without the necessity of making any circuit changes or altering the tuning condensers. The grid leads attached to the coils must be used instead of those employed with the standard coils.

The detector coil (righthand socket) is supplied with the grid condenser and grid leak mounted inside, and has a trimmer condenser at the top for properly locating the band on the dial. This arrangement is not necessary on the R.F. coil, as the trimmer condenser on the set furnishes the capacity necessary for correct ganging.

The detector coil trimmer is adjusted at the factory, but it should be checked, since packing, shipping, etc., may have caused some change. The adjusting screw is at ground potential, so a metal screw drive may be used. When properly set, the low frequency edge of the 14 and 7 mc. bands will be at 125 on the dial on the 11-A and 13-A coil, respectively, while that of the 3.5 mc. band will be at 135 on the 14-A coil. The high frequency edges of all bands will be between 65 and 70.

When the trimmer is finally adjusted, a reasonable amount of care must be exercised in handling the coil or its calibration will change.

INSTRUCTIONS
for
AMATEUR BAND SPREAD COILS

These coils are designed for use in the standard National Thrill Boxes, and may be simply plugged in the coil sockets without the necessity of making any circuit changes or altering the tuning condensers. The grid leads attached to the coils must be used instead of those employed with the standard coils. The 11-A, 13-A, 14-A, and 15-A coils are for use in the ACSW5, DCSW5, ACSW45, ACSW3, (employing 235 tubes), the universal SW3 (DC) and the SW34. The 61-A, 63-A, 64-A, and 65-A coils are for use in the SW58, and the later model ACSW3 employing type 58 tubes.

The detector coil is supplied with the grid condenser and grid leak mounted inside, and has a trimmer condenser at the top for properly locating the band on the dial. This arrangement is not necessary on the R.F. coil, as the trimmer condenser on the set furnishes the capacity necessary for correct ganging. The detector is located at the left hand side in the AC or DC SW5, and the ACSW45 models, and at the right hand side in the SW58, SW34, and all models of the SW3.

The detector coil trimmer is adjusted at the factory, but it should be checked, since packing, shipping, etc., may have caused some change. The adjusting screw is at ground potential, so a metal screw driver may be used. When properly adjusted, the high frequency edges of the various bands will be between 65 and 70 on the dials of the SW5, SW45, and SW3 models, or between 30 and 35 on the dials of the SW58 and SW34. The spread may be increased by slightly tightening the trimmer, so that the high frequency limits occur at a lower dial reading. Conversely, the spread may be reduced by loosening the trimmer.

When the trimmer is finally adjusted, a reasonable amount of care must be exercised in handling the coil or its calibration will change.

BY BILL FIZETTE, W2DGB

A Structured Approach to Fixing up Those Nice Old Radios

Restoring a 1930s National SW-3 Regenerative Receiver

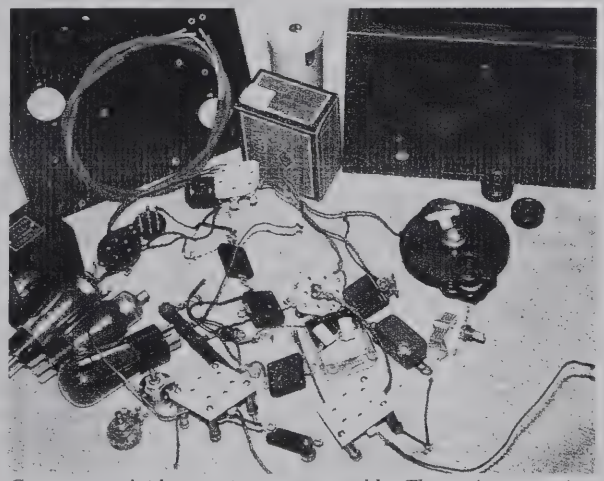
In "The Communications Receiver" for this issue, you'll find a review of the famous National SW-3. In this article we will go through the procedures that were used to restore a rather decrepit specimen that was purchased in the flea market at the 2002 Annual Conference.

While all the major parts were there, a number of them were laying loose in the cardboard box it came in, including the two-gang tuning capacitor and the gain control. Missing were the antenna trimmer capacitor, the gain and regeneration controls, the main tuning dial, the two decorative National knobs, the power cord and plug, and a tube shield, some of the mounting brackets and other miscellaneous hardware. The metal work was rusted badly enough to warrant a complete refinishing.

On the plus side, the difficult-to-replace S-101 audio coupler was said to be good. All in all, it certainly qualified as an interesting project, and will serve to illustrate to a beginner some of the basic procedures used in "fixing up those nice old radios."

First Steps

Two situations had to be resolved before any work could begin; these were acquiring the paper work and obtaining the missing components. The items needed for the former consisted of a circuit diagram, a manual, and notes and sketches of the unrestored chassis. For the latter, we needed the parts already mentioned plus a power supply and tubes.



Components laid out prior to reassembly. The tuning capacitor and the gain control knob are not in this picture.

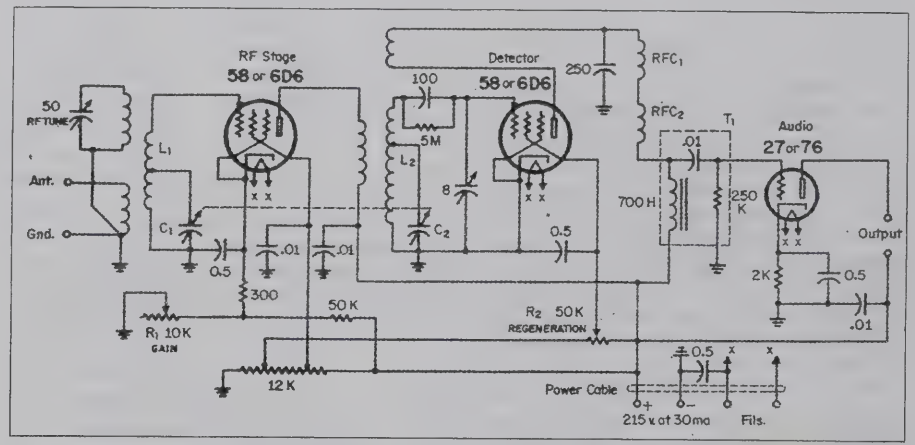
To refinish the metal work it was necessary to strip all the parts off the chassis. This was done slowly so that detailed notes and drawings could be made of all the parts and their inter-relationships as well as the wiring. The original black hook-up wire was saved for reuse where possible.

All parts were then methodically cleaned and checked. The two bathtub capacitors under the chassis were found to be bad, and were gutted so that good modern parts could be placed inside. One hint: If you can locate a good example of the set you are restoring, by all means have it available to check parts layout and wiring hookups. This can be an important aid, especially with a regenerative set where the various grounds are so important.

The Metal Work

The rusted sheet metal parts were sandblasted and then repainted: the inside with a gloss black and the outside with a black crackle. Painting is more of an art form than a science, and some folks are much better at it than I am, especially with black-crackle. My suggestion is to buy only the best materials, and then have someone who knows show or tell you how to do it.

AUTHOR'S ADDRESS: RR 1, BOX55, HENRYVILLE, PA 18332
e-mail w2dgb@enter.net



Circuit diagram of the Model 2 AC version of the SW-3, the most common one, shown here with 2.5-volt tubes. See text. Source: Wm. Orr—CQ Magazine.

In any event, it is difficult to match the original factory job of 70 years ago using the techniques and materials available to the restorer today. But you can at least end up with a product that looks decent.

The two missing metal brackets were bent up out of scrap aluminum and painted. Modern pan-head sheet-metal screws were sand blasted and painted black to replace the missing ones.

Other Parts

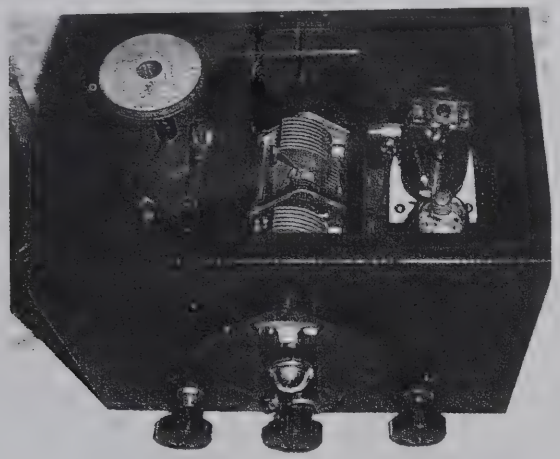
The S-101 coupler (the part that looks like an audio transformer in the center rear of the chassis plate) was indeed good and could be used as is. I just needed to give it a good outside cleaning and repainting with the label carefully masked off. For those who might need it, general information on how to repair an S-101 is included at the end of this article.

All capacitors and resistors were carefully checked, and in this set, for the most part, they were good. However, the detector grid leak was out of spec (maximum of plus or minus 20%) and was replaced with a modern resistor on the premise that it would give quieter operation. The main B+ voltage divider was found to have one leg open, and rather than replace the whole unit with a modern unit with adjustable taps, the open section was simply bridged with a 6900-ohm, 10-watt wire-wound resistor.

The unique four-wire power cable was duplicated by using a large brown cotton shoelace as a cover over the wires. The ends were seized up with heavy thread, and a standard four-prong male power plug attached.

Range (kHz)	Universal Model 3	Model 2	Model 1
90-160	42	72	22
150-220	41	71	21
190-280	40	70	20
250-390	39	69	19
320-650	38	68	18 (purple)
500-900	37	67	17 (yellow)
690-1500	36	66	16 (orange)
1500-2700	35	65	15 (blue)
2500-4500	34	64	14 (green)
4200-8000	33	63	13 (white)
7000-12000	32	62	12 (red)
12000-21000	31	61	11 (black)
19000-35000	30	60	10 (brown)

General coverage coil chart for SW-3 Models 1, 2, and Universal 3. Additional coil sets provided bandspread tuning of ham bands. Source: Wm. Orr—CQ Magazine.



A look into the interior of the reassembled SW-3.

All parts were brush-cleaned with soap and warm water, and any excess solder was cleaned off. All hardware was either replaced or wire brushed to remove the accumulated crud (I use a fine rotary wire brush in an electric drill, mounted in a bench vise). Missing parts as detailed above were located and added to the box.

Coils were borrowed from another set, and tubes selected to match the power supply (see below). Having an aversion to placing headphones carrying over 200 volts DC on my ears, I elected to mount a small audio output transformer inside a speaker cabinet and use that for the output. This resulted in rather weak audio, and headphones matched to the speaker transformer would work better.

The Rebuild

I simply don't trust any soldered connections that were done in the 1930s. It is general practice here to redo each one, examining it under a strong light and a magnifying glass before proceeding to the next one. The guiding principal is that it is easier to do it right the first time, so take your time.

Following my notes, and with another SW-3 to refer to (not necessary, but darned helpful), the SW-3 was reassembled as if it was a kit. Since this is a simple set, and there are not really many parts, no major problems were encountered. However, it was important be sure that the coils and tuning capacitor—including the various grounds—were wired exactly as they were originally done.

Since the metal work was painted, I used a sharp-edged star washer under each ground screw to cut through the paint and make good contact with the metal. This is a good idea even if the metal is not painted, since oxides that can act as insulation will form with time.

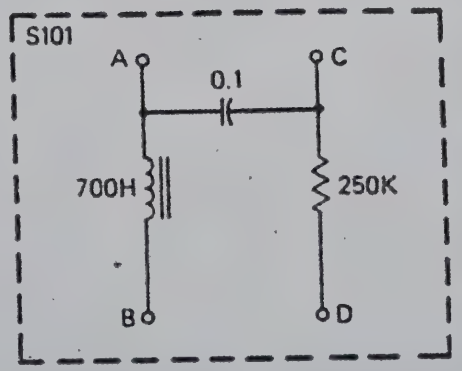
The Power Supply

National made several "doghouse" power packs for regenerative receivers, including the 5880 for 2.5-volt filaments, and the 5886 for 6-volt filament tubes. Since I had a rebuilt 5886, I took the easy way out and used it, along with a set of 6-volt tubes (6D6, 6D6, 37) for the receiver. These packs have a special two-section hum filter, and work well with the various National regenerative receivers from the 1930s. However, one SW-3 restorer[1] informed me that he has had better luck using a voltage-regulated power supply.

One precaution should be noted. If you have a 1941 SW-3 Universal, be sure to disconnect the balancing filament resistor from inside the power pack.

Results

Using a Variac, I slowly applied power while measuring the B+ line. This rebuilt pack, with new electrolytics, supplied about 220 VDC, somewhat above the recommended 180 volts, but still useable. The "smoke test" was satisfactory, and a test signal in the 75-meter band was used to set up the coils. Signals were heard from the first try, but the regeneration was noticeably weaker than needed for today's strong signals. Coils for the 80, 40, and 20-meter amateur bands, as well as the broadcast band, were tried, and signals received on all frequencies. These



Circuit diagram of the S-101 interstage coupler. Source: Wm. Orr—CQ Magazine.

older regenerative receivers can be fussy, and at this writing, I haven't yet invested the time required to tune the set properly. Some of the regeneration problems might well be related to the coil tickler windings, which have to be wound for the particular SW-3 model with which they are used. In this case, "60s series" coils are required. Some of my coils are not marked and may be the wrong type.

Aside from that I consider this project to have been a success. Many of the basic techniques outlined in this SW-3 restoration can certainly be used for the restoration of any of "those nice old radios."

Repairing the S-101 Interstage Coupler

It is entirely possible that you will find an S-101 that has one or more components bad. What to do? Definitely do not discard the unit, since they are very scarce and are repairable. Referring to the diagram and to your unit, you will see the four connections, which for convenience are labeled A, B, C, D.

To check the coupler, the four leads should be disconnected from the set. Although any of the three parts can be bad, the 0.1 mfd coupling capacitor is the usual offender. If it is leaky, open, or shorted, mount a replacement capacitor and resistor outside the box under the chassis, and tape up leads C and D. If the 700 Hy choke is bad (i.e., it won't pass DC) then it will be necessary to take the S-101 apart. First drill out the eyelets from the bottom side, remove the bottom plate, and then gut the case.

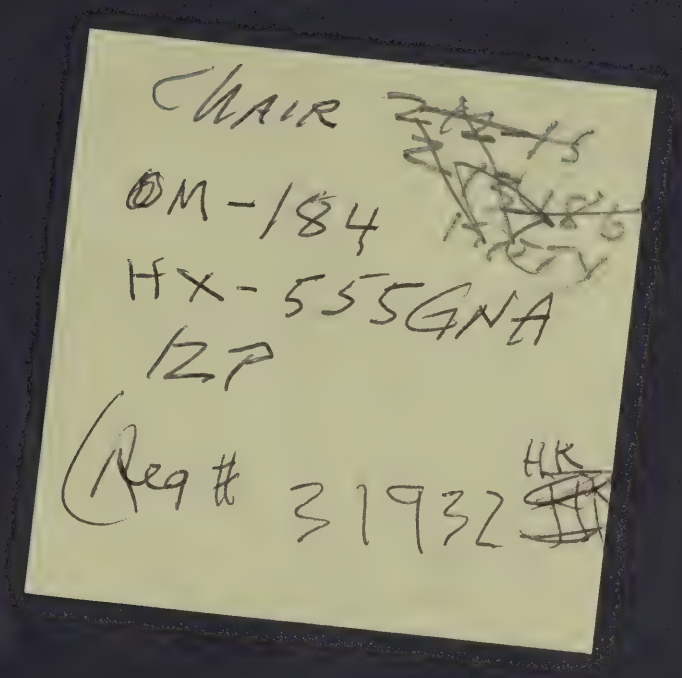
A replacement audio choke can be inserted in the case along with a new capacitor and resistor, and the unit closed up. Hammond makes 70 Hy audio chokes, I am told, and two in series will fit inside the case. Or you might even find a surplus audio choke from WWII stock.

If you wish, the black filler material you scraped out can be melted and poured back into the case. Replacement eyelets can be obtained from a shoe repair shop if you feel the need to have them.

The lesson here: It is possible to repair an old radio component in such a way that the repair is not noticeable from a casual inspection, and the more rare the part, the more desirable it is to take this approach.

REFERENCES

[1] Paul Bohlander, W3VVS, personal communication.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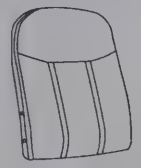
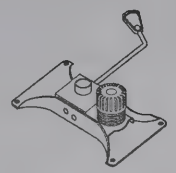
 Part # - BC-01	Part # - SC-01	 Part # - ME-01
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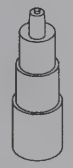
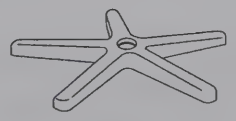
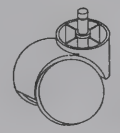
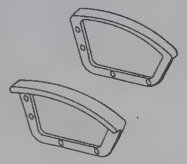
 Part # - GA-01	 Part # - CB-01	 Part # - CA-01
(7) x1		
 Part # - AR-01	A x 8 M6×18 ARM SCREW B x 4 M8×20 MECHANISM SCREW C x 8 ARM CAP	

If any part is missing or damaged, please call:

Si alguna pieza falta o está dañada, llame al:

Si une pièce manque ou est endommagée, veuillez appeler le

1-866-755-1321

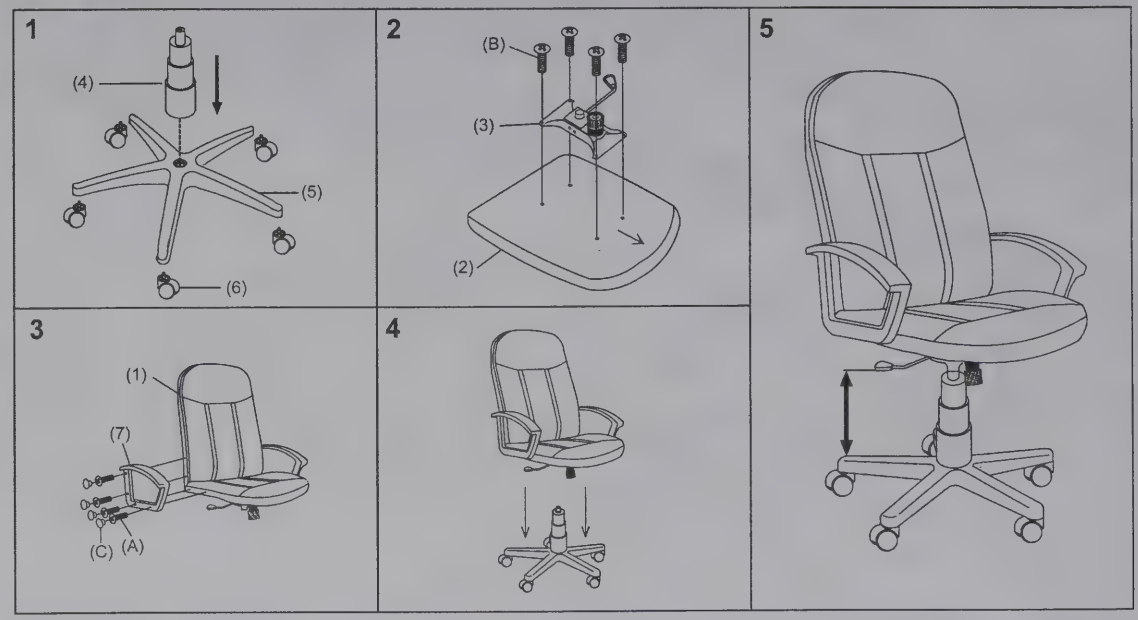
(Mon.-Fri., 8:00 a.m. - 8:00 p.m. Pacific Standard Time)

(de lunes a viernes de 8:00 a.m. a 8:00 p.m., hora estandar Pacifica)

(du lundi au vendredi, de 8 h 00 à 20 h, heure normale du Pacifique)

STOP

Please do not return this chair to the place of purchase.
No devuelva esta silla al lugar de compra.
Ne retournez pas cette chaise au lieu d'achat.



It is important to assemble all parts so that the directional "Arrows" point in the same direction. Make certain that all screws are FULLY tightened before using the chair. Each month, check all screws and tighten any that may have loosened.

Es importante ensamblar todas las partes de manera que las "flechas" apunten hacia la misma dirección. Asegúrese de que todos los tornillos estén bien apretados antes de utilizar la silla. Cada mes revise todos los tornillos y apriete aquéllos que pudieran haberse aflojado.

Il est important d'assembler toutes les pièces de façon que les flèches indiquent la même direction. Assurez-vous de bien serrer toutes les vis avant d'utiliser la chaise. Chaque mois, vérifiez toutes les vis et resserrez celles qui se sont peut-être desserrées.

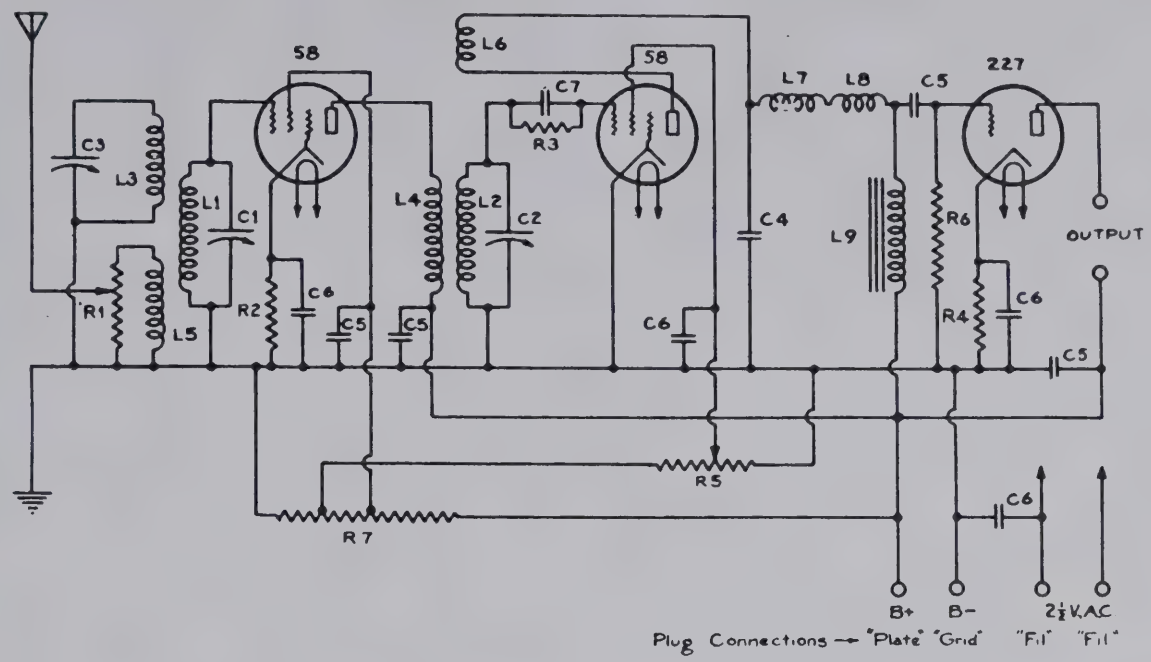


Fig. 4—The a-c model of the SW-3 using 6.3 volt or 2.5 volt glass tubes. This early version of the Model II receiver has the r-f gain control wired as a potentiometer in the antenna circuit. Later models shifted the control to the cathode circuit of the r-f tube so that the operating bias could be increased, dropping the stage gain.

CIRCUIT DIAGRAM OF THE ACSW-3

This receiver employs only a-c tubes, as indicated, and should be selected for complete a-c operation, or for partial a-c operation (using plate batteries) where a 2.5 a-c heater potential will always be available. The circuit constants are as follows —

L_1, L_2, L_3, L_4, L_5 and L_6 — R.F. Transformers.
L_7 — No. 100 Ultra High Frequency R.F. Choke.
L_8 — No. 92 Low Radio Frequency Choke.
L_9 — 700 Henry Choke — Part of S-101 Audio Coupler.
C_1 and C_2 — Ganged S.F.L. 270° Tuning Condensers with isolated rotors. 90-μμf per section.
C_3 — Midget Type Trimmer Condenser — 50-μμf.
C_4 — 250-μμf mica by-pass condenser.
C_5 — .01-μf non-inductive mica fixed condensers.
C_6 — .5-μf non-inductive paper by-pass condenser.
C_7 — 100-μμf small mica grid condenser. Incorporated in Detector R.F. transformer.
R_1 — 3000 ohm potentiometer — special taper — used as gain control.
R_2 — 300 ohm cathode resistor, 2 watt type.
R_3 — 5 megohm detector grid leak.
R_4 — 2000 ohm cathode resistor, 2 watt type.
R_5 — 50,000 ohm potentiometer for regeneration control.
R_6 — 250,000 ohm audio grid resistor — part of S-101 Coupler.
R_7 — Voltage Divider-total resistance 12,000 ohms.

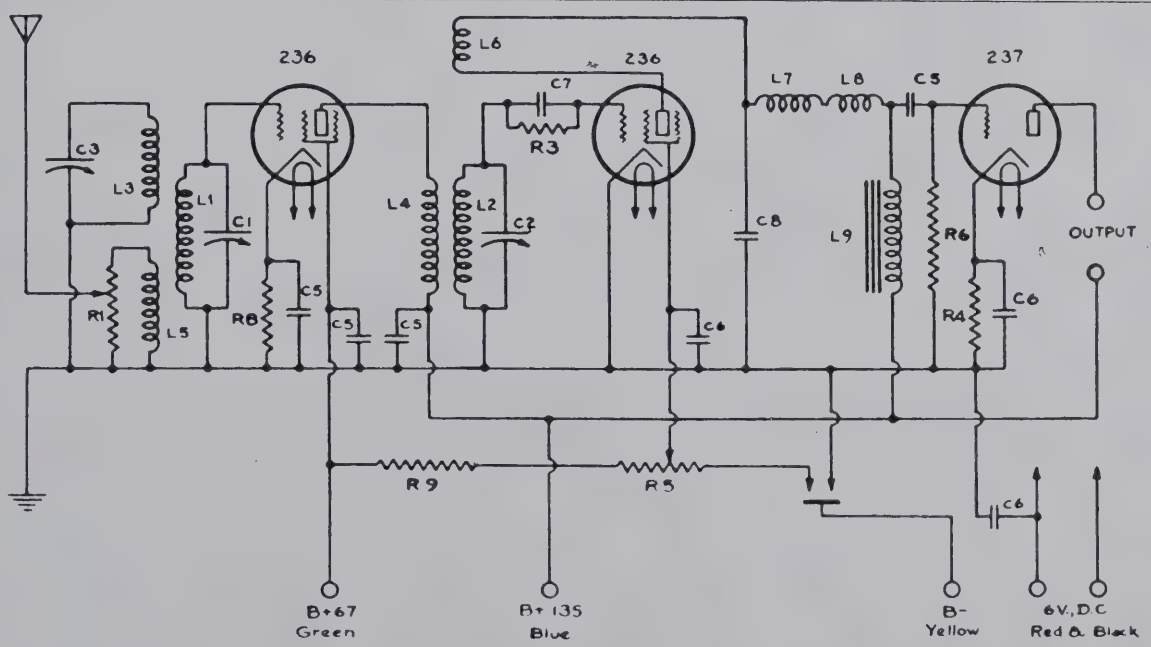


Fig. 5—Circuit of the Model I, version 2 receiver designed for mobile operation or battery operation. Same general circuit as shown in Figure 4 except for addition of a B-plus power switch and the omission of the bleeder resistor for the r-f stage screen supply. A 5-prong power plug is used with this receiver.

CIRCUIT DIAGRAM OF THE DCSW-3

This is the combination circuit which should always be selected when battery operation may be required. It can, however, readily be converted to a-c operation using the standard 235 and 227 tubes. The circuit constants are identical with those indicated in Figure 4, with the following exceptions —

R_8 — 350 ohm resistor.
R_9 — 20,000 ohm 2-watt type resistor.
SW — Regeneration control and cathode circuit switch.

Here's a closer look at one of the most sought after receivers today. Bill Orr takes us down Memory Lane and back again as we refurbish and use the famous SW-3 receiver.

The National SW-3 Receiver: Revisited

BY WILLIAM I. ORR*, W6SAI

In the July, 1971 issue of *CQ* magazine I wrote a short article about the National SW-3 regenerative receiver[1]. Undoubtedly the story struck a responsive chord as I was inundated with mail from SW-3 owners and amateurs hunting for an SW-3 for their collection (fig. 1). The interest was heart-warming and it is encouraging to see so many amateurs taking an active interest in their heritage and showing a curiosity about some of the marvelous equipment that was manufactured for amateurs during the "Golden Years" of amateur radio.

A side effect of the story of the SW-3 was that the market value of a good SW-3 receiver with coils and power supply shot from a range of approximately thirty-five dollars to well over one hundred dollars in a period

*48 Campbell Lane, Menlo Park, CA 94025

[1]Orr, "The Year is 1931. National Radio Introduces the SW-3 All-Wave Receiver", *CQ*, July, 1971, pp. 34-38.

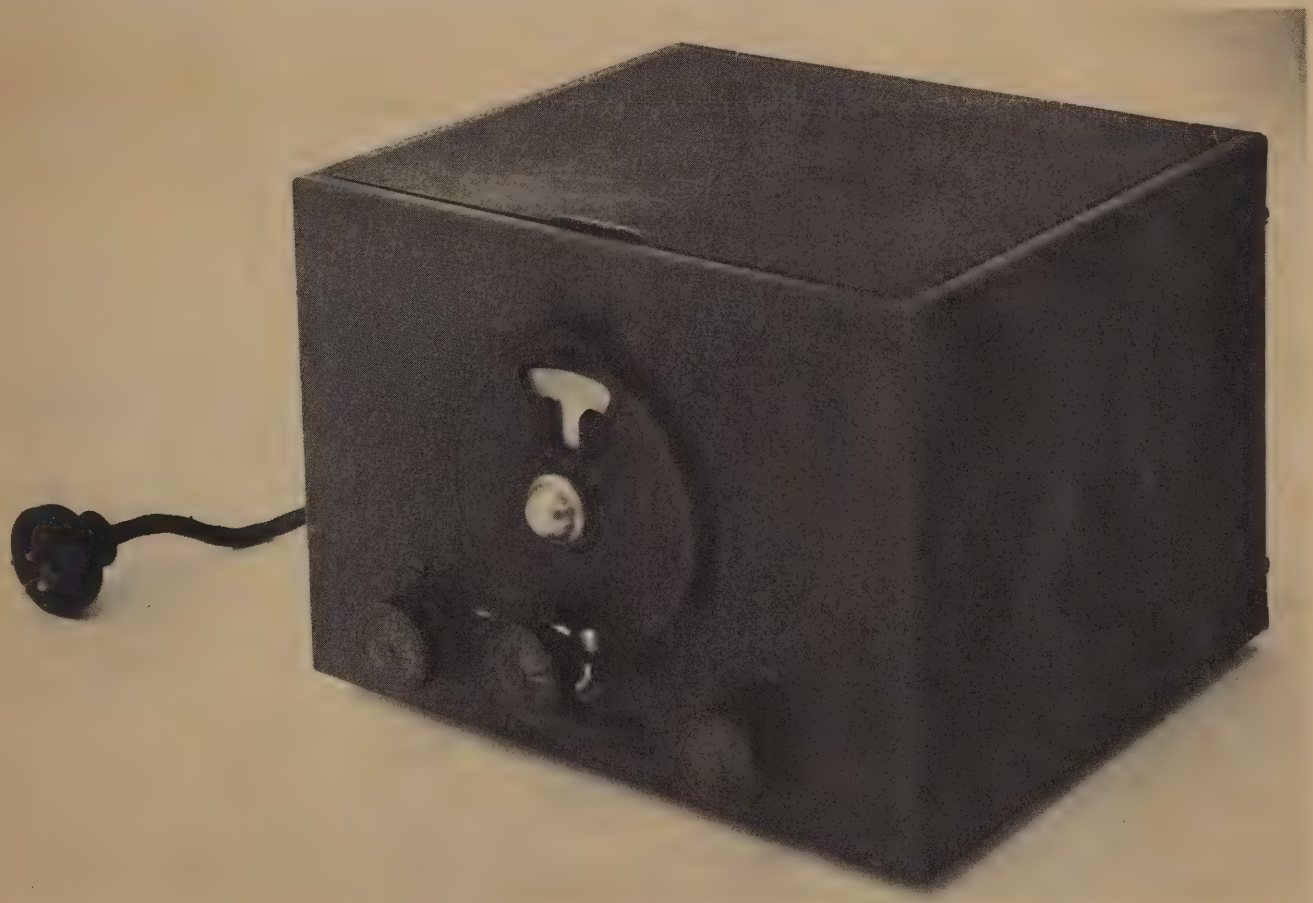


Fig. 1—The popular SW-3 receiver by National Co. This three tube, pre-war beauty is today's hot collector's item. Using plug-in coils, the SW-3 covered all frequencies between 30 MHz and 90 kHz. Panel controls (left to right) are: R-f trim, tuning and regeneration. Below the main tuning dial is the horizontally mounted r-f gain control, calibrated in signal strength units. Receiver required external power supply.

SW-3 Coil Chart
General Coverage

Range (kHz)	Universal Model 3	Model 2	Model 1
90-160	42	72	22
150-220	41	71	21
190-280	40	70	20
250-390	39	69	19
320-650	38	68	18 (purple)
500-900	37	67	17 (yellow)
690-1500	36	66	16 (orange)
1500-2700	35	65	15 (blue)
2500-4500	34	64	14 (green)
4200-8000	33	63	13 (white)
7000-12000	32	62	12 (red)
12000-21000	31	61	11 (black)
19000-35000	30	60	10 (brown)

Fig. 2—Coil data for the SW-3 receivers.

of weeks, and the price is still going up!

Ah, well, they don't make 'em anymore and that's the way the Free Enterprise system works, I guess. In any event, in response to many inquiries, here's some additional information about the SW-3 and its many variations.

SW-3 Variations

As explained in my first article, there are three basic models of the SW-3, with three different versions of Model I. In a few words, this is the story:

SW-3 Model I:

Version 1. Uses 35, 35, 27 tubes and color coded coils. Later coils for this receiver were identified as the "10-20" series.

SW-3 Coil Chart
Bandspread

Band	Universal Model 3	Model 2	Model 1
160	30A	60A	10A (brown)
80	34A	64A	14A (green)
40	33A	63A	13A (white)
20	31A	61A	11A (black)
10	30A	60A	10A (brown)

Fig. 3—Bandspread coil data for the SW-3 receivers.

Version 2. As above, but with 36, 36, 37 tubes and B-plus switch for mobile operation. Used "10-20" series coils.

Version 3. Used 30, 30, 32 tubes (1.4 volts d.c.). Used "10-20" series coils.

SW-3 Model II:

Used 58, 58, 56 (2.5 volt) or 6C6, 6C6, 76 (6.3 volt) tubes interchangeably. Used "60-70" series coils.

SW-3 Model III: ("Universal Model")

Used 6J7, 6J7, 6C5 (6.3 volt) or 1N5, 1N5, 1A5 (1.4 volt) tubes interchangeably. Used "30-40" series coils.

Within these broad classifications there seem to exist many receivers which exhibit small differences. There's a "Marine" model that has toggle switches on the panel for filament control and standby. And I've seen SW-3s that have side handles, apparently put on at the factory. And, of course, many owners of SW-3s in the past have modified or otherwise "butchered" their receivers. Many SW-3s were made into preselectors and some even served as the front-end for home-made superhet receivers. So it is wise to examine the SW-3 before you purchase it or you may be in for an unpleasant surprise.

Receiver Coils

A major problem facing today's owner of an SW-3 is a dearth of plug-in coils. An SW-3 without coils is like a ship without sails. And it is difficult to wind your own coils as the SW-3 coil forms and sockets have an odd-ball pin spacing that matches nothing else!

As the years have passed, coils have been lost or rewound for other purposes and it is a rare receiver that has a full set of coils (fig. 2). In fact, many SW-3s never had a full set of coils, for what 1930 amateur had the pocket money to buy coils at $3.00 a set?

Classified ads and flea markets can often turn up a few coils, but Murphy's Law is still valid and the coils you find may not be the proper ones for your type of receiver, as outlined in the chart. What to do then?

Modifying the SW-3 Coils

It is possible to modify available coils to fit your receiver in many cases. The main differences between the various coil sets are the inductance of the primary and feedback (tickler) windings. The older, Model I receivers used low-transconductance tubes which required a detector coil having a high degree of feedback and a large number of turns in the tickler coil to make oscillation possible for code reception. Hence, the color coded (or so-called 10-20) series coils have more feedback turns than the other coil sets. The feedback winding, by the way, is the winding wound in a slot at the bottom end of the coil. The "60-70" series coils have less turns on the feedback winding, and the "30-40" series of coils have slightly less turns than the "60-70" series coils.

There's a small difference in the plate (primary) winding, too, but that is too much bother to adjust. Besides, I can notice no difference between *any* of the coil sets when the feedback winding is properly adjusted.

It is easy to check a set of coils in your receiver. If the feedback winding is correct, the regenerative detector will go into oscillation when the regenerative potentiometer is set at, or near, mid-position when the r.f. resonator control has been peaked for maximum background noise.

Of course, the point of regeneration also depends upon the plate voltage applied to the receiver, and there's a lot of leeway in regeneration adjustment by merely changing the plate voltage from 90 to 150, or perhaps down to 120 volts.

In any event, the tickler coils can be easily rewound,

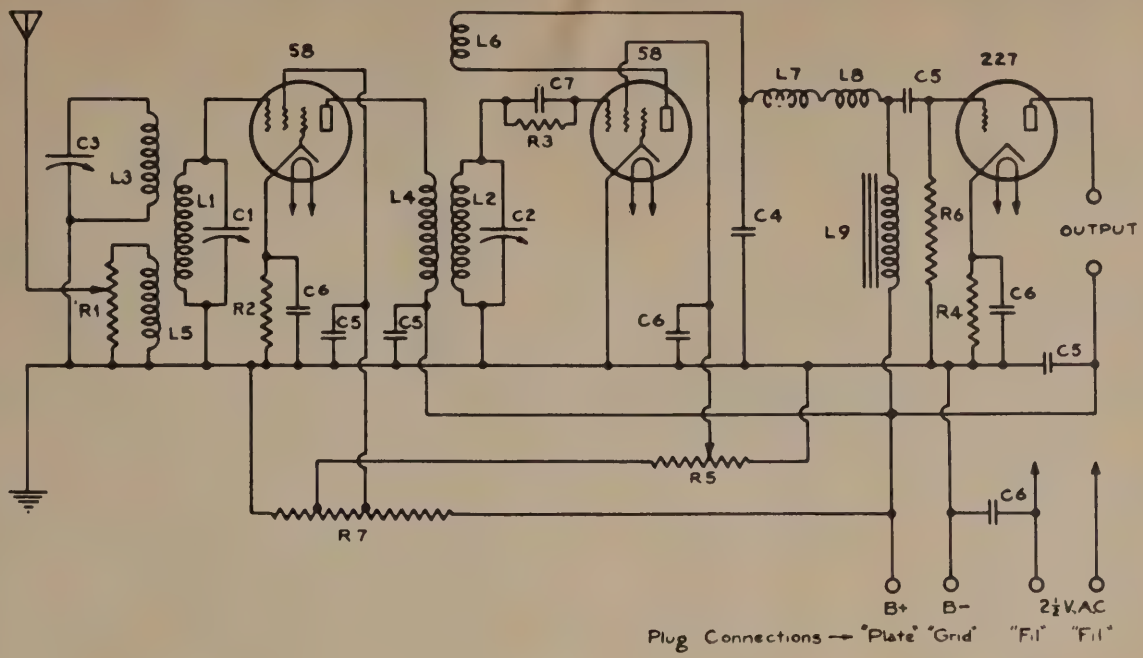


Fig. 4—The a-c model of the SW-3 using 6.3 volt or 2.5 volt glass tubes. This early version of the Model II receiver has the r-f gain control wired as a potentiometer in the antenna circuit. Later models shifted the control to the cathode circuit of the r-f tube so that the operating bias could be increased, dropping the stage gain.

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C_4 — 250-μμf mica by-pass condenser.
C_5 — .01-μf non-inductive mica fixed condensers.
C_6 — .5-μf non-inductive paper by-pass condenser.
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R_2 — 300 ohm cathode resistor, 2 watt type.
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R_4 — 2000 ohm cathode resistor, 2 watt type.
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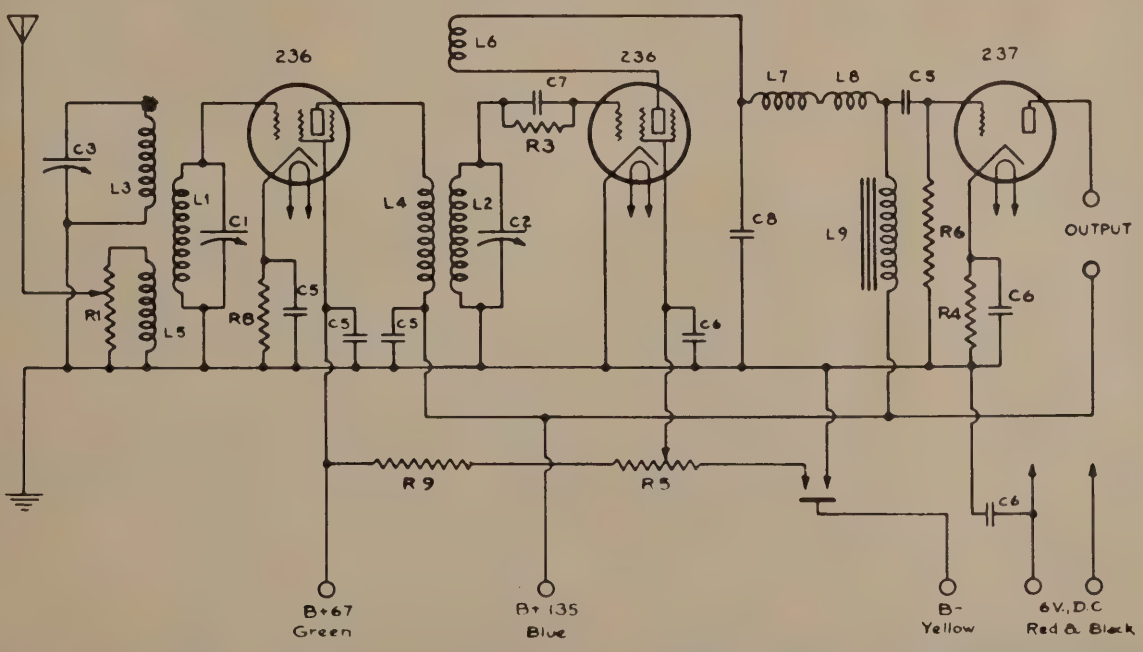

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R_8 — 350 ohm resistor.
R_9 — 20,000 ohm 2-watt type resistor.
SW — Regeneration control and cathode circuit switch.

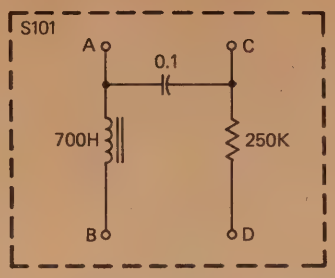

Fig. 6—Interior connections of the "interstage coupler", S-101.

adding or subtracting a turn at a time to provide the proper control settings. A word of warning, however: if you don't want to ruin the resale value of your SW-3, rewind the coils with the same type of wire that was originally on the coil. *(Editor's note: Ho, ho. Try and find green silk covered wire these days!)*

The Bandspread Coils

In addition to the general coverage coils summarized in fig. 2, there exist bandspread coils for the various amateur bands fig. 3. The same remarks concerning the tickler coil may be applied to the bandspread coils Remember, no matter which coils you modify, *make the modification to both coils,* as they are intended to be interchangeable in the detector and r.f. stages of the receiver.

A schematic of the bandspread arrangement is shown in the drawing. You can adjust the exact tuning range of the receiver by means of the variable mica capacitor on the detector coil. And please note that the bandspread coils are unique in that you cannot switch detector and r-f coils back and forth. The detector coil is the one with the mica padding capacitor atop it.

The Long Wave Coils

Fig. 1 shows that coils exist that permit operation of the SW-3 as low as 90 kc (pardon, 90 kHz, that is). These coils are rare birds indeed, and much prized by collectors —especially the coils that cover the 600 meter maritime range. Old timers like to sit and copy ship traffic, for some unknown reason, it seems. Anyhow, the "long wave" coils are a little more cranky, and some of them won't work at all in Model I receivers. The reason? See Figures 4 and 5. In order to sustain oscillation at the very low frequencies, an additional r.f. choke must be placed in the plate circuit of the detector tube. If this choke (L_8) is missing (as it is in early production sets), the detector refuses to oscillate much below 500 kHz. Later production receivers incorporated two r.f. chokes in series and effectively solved this problem.

Even so, after adding the r.f. choke and fiddling with the tickler winding of the detector coil, on occasion I have been completely frustrated trying to make a particular SW-3 perform properly with a set of low frequency coils not matched to the receiver. And the coils are wound in such fashion that modification of the other windings is very difficult. So beware! *Some* low frequency coils may not work in *some* receivers!

Take the SW-3 Apart?

Why not? Some of them are incredibly dirty and should be thoroughly cleaned before operation is accomplished. Outside, the black crackle finish can be cleaned by scrubbing is vigorously with a rough towel dunked in a warm solution of tri-sodium phosphate (TSP at your friendly hardware store). And you can tell if a previous owner was a cigarette or cigar smoker. You'll get a sticky, yellow *guck* off the receiver chassis that smells like a dead ashtray after a New Year's party.

Once the outside is reasonably clean, you are ready to take the receiver apart. These are the steps:

1- Remove the bottom plate and the four sheet metal screws on the sides of the receiver. Remove the lid and back plate.

2- Remove the two front sheet metal screws. Remove the two knobs at the sides of the front panel. Remove the lock nuts on the regeneration potentiometer and the antenna resonating capacitor. Loosen the set screw for the tuning shaft under the center cap on the dial.

3- Inside the receiver, unsolder the two ground lugs on each internal shield. The lugs lie on each side of the tuning capacitor.

4- Unscrew the three tiny nuts that hold the dial in place.

You can now slide the chassis out of the cabinet, first making sure the dial light is removed from the panel clip. The chassis and interior of the cabinet can now be cleaned with the TSP solution and the rough towel.

Want to remove the dail to clean the rotary disc? You can do it now. The dial comes apart if you take off the knob. You'll see that the dial assembly is held together by means of a locking pin on the dial drive shaft. If you remove that.....easy! Watch out! There is a pin-spring-bushing assembly at this point. Study it before you pull the pin. Everything is under tension.

When I took my dial apart the first time I pulled the pin out of the shaft with a long-nose pliers. There was a loud *twang.* The spring and bushing flew out. A nearby window was conveniently open. I watched with open-eyed horror as spring and bushing flew out the window into the yard. It took a good 15 minutes of painstaking search to find the spring and bushing. In fact an ant was already hauling the bushing off to feed it to its offspring!

Keep track of all loose hardware! Once everything is in ship-shape you can reverse the process and reassemble the receiver. Oh, yes! Notice that the condenser drive shaft of the dial has a phenolic insert and the dial is electrically insulated from the tuning condenser shaft. This is done to reduce dial noise, which can show up when two ground returns exist in the tuning system. *Don't* loose this bushing.

While you are at it, you might as well check out the interstage coupler in the tin can at the back of the receiver (fig. 6.) Use an ohmmeter for this. In fact, it is a good idea to measure this unit *before* you buy an SW-3. If the primary choke (L_9) is open, you have a problem, as they ain't making replacement parts anymore!

Receiver Overload

Back in the Golden Years of amateur radio most amateurs ran inputs of 10 to 100 watts, with the majority of signals running at the 50 watt level. The "California Kilowatt" was not unknown, to be sure, but it was a very subdued beast.

Today's electronic environment does not suit the SW-3 well. A regenerative detector is very susceptible to overload and the overload capability and strong signal rejection of the SW-3 are poor compared to today's modern receiver. The worst thing you can do to your SW-3 is to hook it on to your beam antenna. The receiver will choke on the strong signals of 1978.

A good antenna for the SW-3 consists simply of about 20 to 30 feet of wire, high and in the clear. Use a good

(Continued on page 75)

Speech Processing *(from page 72)*

of infinite clipping. In such a situation the output of the clipper is just a square wave signal. Again low frequency roll off was used before the clipper. This time to reduce the power of harmonics from the low frequency first formant signal due to clipping from interfering with the second formant signals. The optimum high pass filter was found to have a 1.1 kHz cut off frequency with a 12 db/octave roll off. The result is shown in curve **A**. At positive S/N ratios it beats curve **C** somewhat, but at negative ones it rapidly falls off. This is probably due to the fact that even with the filter, harmonics of the lower frequencies are still present, and therefore still interfere with the second formant.

Finally, a fast time constant compressor was tried again with a high pass filter before the compressor. The optimum high pass filter was found to be a two kHz cut off frequency with 6 db/octave roll off. The results are shown in curve **D**. It was the best of them all except for very low S/N ratios. This is due to the fact that compression creates much less harmonic distortion than does clipping.

Finally, that customary question "How does it sound?" I tried a syllabic compressor with the 2 kHz filter and recorded it. You could tell that the speech was not normal since it lacked lows, but it was by no means garbled. It had a very crisp sound to it, but it did not make me sound like the medieval Italian *Castrati.* During an on the air test, one station asked me to turn it off because he didn't like its sound. On the next go-round he asked me to turn it back on again since he was missing an occasional word. Then I knew it must be working! Other comments were that it was "easy copy" through the QRN on 75 and QRM on 20.

In summary, doing processing at the r.f. level is better since harmonic distortion is easy to filter out, compression is better than clipping since less harmonics are generated to begin with, and low frequency roll off reduces these harmonics even further and gives a crisp easy to *copy* sound. Most important, intelligibility is the criterion not fidelity; how does it work is more important than how does it sound. ■

SW-3 Revisited *(from page 40)*

ground connection on the receiver. Finally, place a mica compression trimmer in series with the antenna right at the receiver terminal. Use as little capacitance as you can and still get good, strong signals. You will be surprised at how little capacitance is needed. The SW-3, in fact, will perform wonders with as little as 10 feet of antenna wire on the higher bands. For 80 and 160 meter reception, a minimum of 20 feet of wire is suggested.

The sensitivity of the SW-3 is amazing. Properly peaked up and with optimum antenna coupling, you'll hear everything your station receiver can hear, right down to the background noise. You'll be limited by antenna pickup, since you are probably used to having a beam hooked to your station receiver. But the SW-3 has "ears" like an Iroquois Indian scouting party, so don't be surprised when you hear that exotic DX-pedition station rolling in on the little receiver.

Receiver Power Supply

The SW-3 works very well at a plate potential of 90 to 150 volts. At the lower plate voltage, you may find that the receiver won't break into regeneration on the lower frequency coils. You can use a National power supply (if you can find one). I use a small, surplus 140 volt regulated supply that does the job nicely.

Examine your SW-3 to see if one side of the filament leg is grounded in the receiver. Most of them are wired that way. A few receivers, however, have the filament circuit

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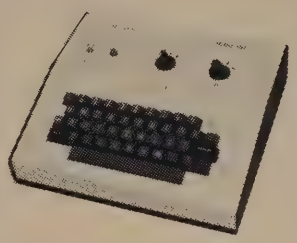

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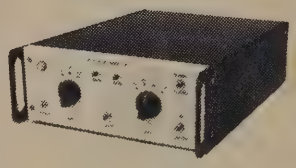

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ungrounded. One leg of the filament should then be grounded in the power supply, or a hum may exist on strong signals. Other receivers have a built-in filament center-tap resistor and these receivers should use a filament supply that is not grounded in the power supply.

Good Luck With Your SW-3

This little set is a popular collector's item and its value will increase as the years go by. Best of all, you can hook it up and listen to it! You must use high impedance earphones (2,000 ohms to 5,000 ohms). Low impedance phones just won't work unless you place a matching transformer between the receiver and earphones. A pee-wee transformed to match a pentode output tube to a speaker voice coil will work OK.

Get your receiver working and start listening. You'll be surprised at the DX you can hear! ■

Computers *(from page 30)*

Interested in conversation with your computer? While not truly a reality, hobby grade equipment is available allowing the hobbiest to experiment with speech synthesis and recognition.

Word processing is available on some systems with the appropriate hardware and software. This might be used for putting the professional touch on letters and documentation.

Perhaps some software to help children with their math homework or a recipe file for the wife would be useful.

Amateur radio users can use their system to send and receive code and to process, transmit, and display slow scan television images, plus do their logging.

Where Are They Available?

Computer equipment is available through mail order houses or local computer stores. The potential buyer should be careful to deal with a reputable firm. Although the hobby computer industry is relatively young many businesses have found themselves forced to close their doors. Continued price declines and increased product offerings will almost certainly contribute to the demise of many more in the next year. Those who feel a deficiency in computer hardware or software should seek the assistance of other hobbiests or professionals in their area.

Is It Really Worth It?

Caution should certainly be exercised while considering entry into any avocation. It is important not to become overwhelmed by the potential problems. If the possible rewards or gains of hobby and personal computing are assessed realistically by an individual, the answer to the question "Is it really worth it?" can be a resounding YES! Even if a decision is made not to enter into hobby computing at the present time, keep it in the back of your mind—the situation might change tomorrow.

Coming Up In Future Issues

Future issues of *CO* will contain articles on Computer Hardware and Software—"What are They" and "How Do They Work" along with reviews of products of particular interest.

Next: COMPUTER? What is it?

TVI and CB *(from page 28)*

issued Docket No. 21116, which proposes to amend the Commission's Rules to prohibit the marketing of external radio frequency amplifiers capable of operation on any frequency from 24 to 35 MHz.

Finally, as a result of CB-RFI problems which are related to the use of Amateur transmitters and transceivers by communicators on the 27 MHz Citizens Band, and because such Amateur equipment does not now fall under the Commission's regulations on type acceptance and marketing, the Commission has issued Docket No. 21117. This Docket proposes to amend the Commission's Rules to require type acceptance of equipment marketed for use by operators in the Amateur Service. And while the Commission would not require the spurious and harmonic attenuation levels of type-accepted Amateur transmitters to be as great as those imposed on CB transmitters, the fact that type acceptance might be required for Amateur equipment represents a departure from the traditionally-held view that such regulations impede the innovative process within the Amateur Service.

To say the least, Amateurs have much at stake in the deliberations which address CB-RFI. As such, we can ill afford to ignore the effect such proceedings might have on the Amateur Service.

The Bottom Line

The FCC study on television reception difficulties associated with CB radio transmitters indicates that TVI (and, indeed, RFI, in general) is a very serious problem. Further, given the fact that millions of households are now affected by RFI, and that increased regulation of the CB and Amateur Services may evolve as a result of such interference, it behooves all parties concerned—the radio operator, the manufacturers of CB and Amateur equipment, the manufacturers of electronic home-entertainment equipment, and the Commission—to work together in resolving RFI problems. Such a coordinated approach appears to be the only way in which to resolve for all time one of the most complex problems facing the CB and Amateur Services.

Copies of the report, entitled "The Extent and Nature of Television Reception Difficulties Associated with CB Radio Transmissions," are available for inspection at the FCC's Public Information Office, Room 202, 1919 M Street, N.W., Washington, D.C. The report may be purchased from the Downtown Copy Center, 1730 K Street, N.W., Washington, D.C. 20006. Telephone (202) 452-1422. ■

The Giant LCD Clock *(from page 23)*

indoors on a very cold day, the display may not read correctly—one or more "extra" segments may light up. This happens because of condensation between the IC or LCD sockets' closely spaced "lands" on the PC board, or moisture between the contact areas on the LCD itself. Normal drying in warm room air should alleviate the problem. Plug in the clock and let it operate for 15 to 30 minutes to restore normal operation.

Back-Lighting The Display

If you add a small fluorescent or incandescent light source *behind* the LCD the visibility of the large time numerals will improve. The light should be mounted out of direct line of sight, so as to cast light on the display, without the light-source itself being visible through the LCD panel. An angle-mounted plane mirror is a good choice for reflecting light onto the display. Choose one about the same width as the LCD panel and about half its height. Alternatively, aluminum foil can be used as a flexible, easily worked reflector. ■

Warning

The digital clock is powered *directly* from the a.c. line. Accordingly, it should be housed in an insulated case or enclosure, to protect children and non-technical admirers from accidently touching "live" connections and receiving from accidentally touching "live" connections and receiving a shock.

John,

This is the manual that came with the SW-3. It is in pretty good condition Except for the blemishes you see on the cover. Apparently some "silver-fish" or the paper moths found it during a long period of storage. I always kept the receiver and the manual together until once when I had it at the radio table and tucked it into the Olde Goal Roster folder. So, I am glad the subject of W4SA (Durham) came up today. I found the manual I could not find when I gave you the SW-3 —— 73 Nelson

INSTRUCTIONS
for
AMATEUR BAND SPREAD COILS

These coils are designed for use in the standard National Thrill Boxes, and may be simply plugged in the coil sockets without the necessity of making any circuit changes or altering the tuning condensers. The grid leads attached to the coils must be used instead of those employed with the standard coils. The 11-A, 13-A, 14-A, and 15-A coils are for use in the ACSW5, DCSW5, ACSW45, ACSW3, (employing 235 tubes), the universal SW3 (DC) and the SW34. The 61-A, 63-A, 64-A, and 65-A coils are for use in the SW58, and the later model ACSW3 employing type 58 tubes.

The detector coil is supplied with the grid condenser and grid leak mounted inside, and has a trimmer condenser at the top for properly locating the band on the dial. This arrangement is not necessary on the R.F. coil, as the trimmer condenser on the set furnishes the capacity necessary for correct ganging. The detector is located at the left hand side in the AC or DC SW5, and the ACSW45 models, and at the right hand side in the SW58, SW34, and all models of the SW3.

The detector coil trimmer is adjusted at the factory, but it should be checked, since packing, shipping, etc., may have caused some change. The adjusting screw is at ground potential, so a metal screw driver may be used. When properly adjusted, the high frequency edges of the various bands will be between 65 and 70 on the dials of the SW5, SW45, and SW3 models, or between 30 and 35 on the dials of the SW58 and SW34. The spread may be increased by slightly tightening the trimmer, so that the high frequency limits occur at a lower dial reading. Conversely, the spread may be reduced by loosening the trimmer.

When the trimmer is finally adjusted, a reasonable amount of care must be exercised in handling the coil or its calibration will change.

ADDITIONAL SW3 TUNING NOTES

In order to secure the maximum sensitivity of the SW-3 "Thrill Box," it is essential that the trimmer condenser (the left hand knob) be correctly adjusted. No signal is necessary when the alignment is being made. Set the regeneration control (right hand knob) at a point just below oscillation. When the trimmer condenser is rotated back and forth it will be found that the detector does not oscillate evenly. The regeneration control should be turned slowly to the left, meanwhile rotating the trimmer back and forth, until the point is reached where oscillation occurs only at one definite setting of the trimmer knob. This setting is the one which exactly aligns the R. F. stage. In other words, the detector oscillates with greatest ease when the trimmer is correctly set.

After the operator has become familiar with the controls of the receiver, it is possible to set the trimmer accurately by listening for an increase in background noise as the knob is rotated.

It is probable that the trimmer will need to be reset occasionally, as the tuning dial is varied from one end of the scale to the other, or when a different set of coils is employed.

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